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Environmental Status of 28 Oil and Gas Exploration Areas of Operation in the National Petroleum Reserve-Alaska

December 1992

U. S. Department of the Interior
Bureau of Land Management
and the U. S. Geological Survey

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Environmental Status of 28 Oil and Gas Exploration Areas of Operation in the National Petroleum Reserve-Alaska

A Joint Cooperative Team Study
by the Bureau of Land Management
and the U. S. Geological Survey

December 1992

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INTRODUCTION

REPORT PURPOSE AND ORGANIZATION

BACKGROUND

The following scientific and technical review is a cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of 28 areas of operation utilized for intensive oil and gas exploration during the 1974-1982 federal program in the National Petroleum Reserve in Alaska (NPRA). The effort was precipitated by the 1973-74 mid-east oil crisis. The congressionally mandated exploration program is comprehensively discussed in Geological Survey Professional Paper, 1399 by George Gryc. After the last exploration activity was completed in 1982 a comprehensive cleanup and monitoring program was initiated.

This report is the product of a intensive two week multidisciplinary meeting by a review team of senior scientists supported by five additional review scientists who had extensive experience on the NPRA. This review does not attempt to present or review regulatory or legal opinions.

OBJECTIVES OF THE JOINT AGENCY CHARTER

A Joint Agency Charter was prepared in the winter of 1991 as a guide for completion of the plan of study. The principal objectives of this plan of study include the following:

- Establish, review and aggregate an information base using existing and available data.
- Develop a methodology and conduct an orderly, systematic environmental evaluation of the 28 wellsites.
- Establish a system of internal coordination between BLM and USGS.
- Identify a method and evaluate the information bases in comparison with the legal and regulatory framework to determine the environmental status of the 28 NPRA wellsites.
- Determine appropriate and necessary field visits to 28 NPRA wellsites and other sites that may be relevant.

DELIVERABLES

- A review of existing data and literature on the 28 wellsites.
- Assessment and evaluation risk screening of the status of the areas of operation.
- Catalog information for each wellsite.

PROJECT SPONSORS

The project sponsors are Ed Spang, Alaska State Director, BLM, and Jim Devine, Assistant Director, USGS, who provided management support and commitment. The project sponsors were responsible for approval of the project charter. The project sponsors approved the project plan consistent with their responsibility for oversight of project activities. The project sponsors were responsible for final decisions on project strategies.

REVIEW TEAM

A review team focused on aggregating and analyzing existing information for the project sponsors. The interdisciplinary review team was the project sponsors' principal representative for all Project activities.

Interdisciplinary Review Team members were:

Jack Peterson	Special Assistant to the Director-BLM
Dick Dworsky	Special Assistant to the State Director-BLM
Jack Mellor	Associate District Manager, Steese/ White Mountain District Office-BLM
Joe Dygas	Chief, Branch of Lease Operations-Alaska SO BLM
Ozzie Girard	Deputy Ass't Director For Enginering Geology-USGS
Herman Feltz	Geologist-USGS
Jim McNeal	Deputy Ass't Chief Geologist For Programs-USGS

The technical support group who assisted in the analysis were Max Brewer, Jilann Brunett, George Gryc, and Gary Solin of USGS, and Don Mears of BLM.

The interdisciplinary review team convened in Anchorage for two weeks in May 1992 to examine and analyze all existing information for each of the 28 exploration wellsites. The project sponsors, the review team and the technical support group then visited most of the wellsites in July 1992 to validate their findings. During this week-long field validation, additional assistance was provided by the Alaska Fire Service with helicopter and fixed wing aircraft.

The interdisciplinary review team discussed the status of each wellsite attempting to understand the current state of its interaction with the surrounding tundra environment. To guide its deliberations, the team used the risk screening methodology derived using the State of Alaska Division of Environmental Conservation guidelines.

For each of the 28 NPRA exploration wellsites, a consensus was achieved based on the collective professional judgments and knowledge resident within the team and support staff and information from existing studies. As noted from a review of the comprehensive bibliography at the end of this report, a large number of studies exist regarding the soil, water, natural resources and ecology of the Arctic

tundra, many of which are specific to the National Petroleum Reserve in Alaska. The collective experience of the twelve member cadre, which examined the existing reports and visited the sites, represented some 300 years of technical experience, much of it in Alaska and the Arctic.

ORGANIZATION OF REPORT.

The main report consists of the introduction, methods, findings and discussion of broad areas of interest. Appendix A includes separate chapters of summary data for each of the 28 wellsites. The information for each wellsite consists of: an airphoto, soil and water sample information maps, an evaluation sheet for Wellsite Risk Determination, a Description of Wellsites and Summary of Water Quality and Soil Assessments, and a specific topical bibliography. Other appendices contain a comprehensive NPRA bibliography .

ENVIRONMENTAL SETTING

The National Petroleum Reserve in Alaska(Figure 1.) is a contiguous area of some 23 million acres located on the Arctic Slope of Alaska and fronting on the Beaufort and Chukchi Seas. NPRA is about the size of the state of Maine. It was originally designated as Naval Petroleum Reserve No. 4 by an Executive Order signed by President Harding in 1923. It was given its current status by Congress through passage of the National Petroleum Reserves Production Act of 1976. Management of NPRA is vested by Congress with the Department of the Interior. The Bureau of Land Management has overall management responsibility for NPRA although USGS had the responsibility for the 1974-82 petroleum exploration program.

The Alaskan Arctic region, and particularly NPRA, are commonly divided into three physiographic provinces: the Brooks Range, the Arctic Foothills, and the Arctic Coastal Plain. The Arctic Coastal Plain, in which most wells were drilled, is a relatively flat, lake-dotted tundra plain rising gently from sea level to a height of 600 feet. It is a poorly drained region, with about 30 percent of the surface covered by water. It is characterized by thousands of shallow lakes, thaw lakes and drained lake basins, ice-wedge tundra polygons, numerous meandering rivers and streams, a large area of vegetated and unvegetated sand dunes, and is fronted on the north by numerous lagoons.

Due to the flat terrain and continuous permafrost, drainage on the coastal plain is very poor, and marshes are present in most low areas. Rivers crossing the coastal plain empty into the Chukchi or Beaufort Seas.

Permafrost is a dominant feature of the NPRA. It consists of ground whose temperature has remained below the freezing point of fresh water for two to many thousands of years. Local variations in thickness, and temperature of permafrost depend on differing thermal properties of the earth materials, local

differences in climate, topography, vegetation, geology, hydrology, and the rate of heat flow. The entire study area is underlain by continuous permafrost extending from a few inches to a few feet below the land surface and ranging in thickness from 600 to 1,200 feet. Permafrost retards surface water drainage infiltration Combined with low relief the results are wet, shallow, poorly drained soils with relatively high organic content which is minimally decomposed. These soils are highly susceptible to thawing when protective vegetation is disturbed.

A concise overview of the land and resources of NPRA appears in "The National Petroleum Reserve-Alaska, A Reader" prepared by BLM Alaska State Office in February 1991, and are comprehensively reported in the multiple study reports comprising the "National Petroleum Reserve-Alaska 105(c) Land Use Study" prepared by a multi-agency task force led by BLM Alaska State Office in 1978. As those reports document, NPRA is rich in both renewable and non-renewable resources including:

- A major portion of one of the most prolific oil and gas producing geologic systems on the North American continent.
- More that 40 percent of the coal reserves in the United States.
- High grade metal deposits of lead and zinc, and occurrences of associated metals such as silver, chromium, nickel, copper and the platinum group, as well as other minerals such as barium, fluorine, and phosphate .
- Recreation and cultural values, including more than a thousand historic and prehistoric sites.
- Significant Arctic wetland ecosystems that support black brant, Canadian geese, pintail ducks, swans, whitefronted geese and shorebirds.
- Other riverine habitats that support arctic peregrine falcons, muskox, fur-bearers and overwintering fish.
- Upland area that support caribou and barren ground grizzly bear.
- A people who have inhabited it for 8,000 years, and still depend upon it for much of their subsistence.

These resources offer different users a variety of opportunities which can lead to conflicts between development and preservation, traditional uses and national needs, recreation and subsistence and can raise questions of local control, transportation routes and cultural change.

WELLSITE DATA COLLECTION

USGS and BLM agreed to cooperatively sample wellsites in the NPRA. As part of this agreement, USGS evaluated water and soil conditions at 28 exploratory wellsites in NPRA (Fig. 1 and Table 1). These 28 exploratory wellsites were constructed under contract to the U.S. Navy or the USGS from 1975 through 1981. BLM became the land manager with the passage of the National Petroleum

Figure 1.--Location of exploratory wells on the National Petroleum Reserve in Alaska, sampled during 1989-90.

Reserves Production Act of 1976. All State of Alaska and Federal regulatory laws and management responsibility apply to actions on NPRA.

Although numerous studies have been conducted in NPRA, several specific wellsite inspections and studies have been conducted since the exploration program was terminated. In 1983, personnel from USGS visited 5 wellsites; in 1984, personnel from the Nuera Reclamation Company visited 13 wellsites; in 1989, personnel from USGS and BLM visited all 28 wellsites; and in 1990, personnel from USGS and BLM revisited 11 wellsites (Table 1) to further identify the occurrence and distribution of chemical constituents associated with past drilling activities and to evaluate physical disturbances at the wellsites. Several organic and inorganic chemical constituents were chosen for analysis in each of these studies to determine the quality of water and soil several years after drilling ended.

An open-file report (OFR 91-458) was published by USGS based on the 1989 and 1990 USGS & BLM visits to the wellsites. This open file report and raw analytical sampling data from each site were reviewed by an interagency, multidisciplinary panel of senior scientists and technical experts to determine the environmental status and potential impact of the wellsites on the tundra environment.

METHODS

WATER AND SOIL SAMPLING

In 1983, after several years of natural environmental recovery, five wellsites were visited to make on-site measurements of properties and to sample water and soil for selected organic and inorganic constituents(unpublished data on file in Office of the U.S. Geological Survey, Anchorage, Alaska, 1984). Following the 1983 study, an environmental remediation firm was hired to obtain and analyze water and soil samples from 13 selected wellsites on the NPRA. Ancillary contractual requirements included a botanical survey of the wellsites, picking up any debris, and recutting of any pilings that then projected above land surface because of continued settlement of the drilling pads. (Nuera Reclamation Company, 1986).

In 1989, USGS and BLM decided to further characterize the quality of soil and water at wellsites by identifying the occurrence and extent of chemical constituents that might exceed water-quality standards and criteria promulgated by both the United States Environmental Protection Agency (USEPA) and the Alaska Department of Environmental Conservation (ADEC). Chemical analyses were done using analytical methods approved by USEPA and ADEC.

Because of the large number of wellsites (28), the limited Arctic field season (lakes are ice free for about one and a half months), and the high probability of losing at least a few days because of heavy fog along the coast, field time was

scheduled for about one day for most wellsites visits during each field season. The following activities were completed in 1989 and 1990:

1. A vertical-level survey was made at each wellsite to measure direction of drainage and relative elevations of water surfaces and to determine sample locations.
2. A soil-gas survey was made at 21 wellsites: 19 wellsites in 1989 and 2 in 1990.
3. Earth conductivities were measured at each wellsite in 1989 samples.
4. Water and soil samples were collected at specific sample locations at every wellsite to determine concentrations of selected organic and inorganic chemical constituents.
5. Water at sample locations and in the surrounding ponds at every wellsite was examined on-site for water temperature, pH, specific conductance, alkalinity, and dissolved oxygen.
6. Photographs were taken from the air and the ground to document wellsite conditions.

The basic focus of the soil and water sampling was on the possible sources of chemical constituents that exceeded maximum contaminant levels (MCL) in water or background conditions (defined by the U.S. Environmental Protection Agency and/or State of Alaska Department of Environmental Conservation proposed regulations) in soil at the wellsites. These could include: (1) components of normal drilling muds, (2) well cuttings and natural hydrocarbons, and (3) hauled-in-drilling make-up water and pad fill materials. On the basis of these sources, several samples of water and soil were collected and analyzed for selected inorganic and organic constituents.

Reports of previous work, topographic maps, and aerial photographs were used to help establish sampling locations before the wellsite visit; however, some sampling locations were changed as additional information became available before and during each wellsite visit.

In general, the specific locations where soil samples were collected are 0.2 to 1.0 ft below land surface at the following locations: 200 ft upgradient from the reserve pit, in the center of the reserve pit, 50 and 200 ft downgradient of the reserve pit, and in the center of the drilling pad. Additional samples were collected as appropriate: in areas of stressed vegetation; at a site 50 ft downgradient of a leak in the reserve pit containment berm, in flare pits, in fuel storage pits, or in areas where earth conductivity, soil gas, pH, or specific conductance measurements were high. Where possible, water samples were collected at the same locations as soil samples.

On the basis of the findings of the 1989 investigations, further investigations were conducted in 1990 at the following wellsites: East Simpson No. 2, East

Teshekpuk, Ikpikpuk, Inigok, Koluktak, Peard, Seabee, South Meade, and Tunalik. The 1990 field investigations focused on the following work objectives:

1) Determine what influence the sampling network design had in identifying sites with constituents having elevated values.
2) Determine the range of background concentrations of total petroleum hydrocarbons (TPH) and hexavalent chromium near the wellsites.
3) Determine seasonal variability in hydrologic conditions at several wellsites.
4) Evaluate the influence of "freeze concentration" in concentrating organic and inorganic constituents in the liquid phase in and around the reserve pits.
5) Revisit sites because of specific problems -- for example, elevated concentrations of organic or inorganic constituents -- that were identified during the 1989 investigations.

In order to determine whether the concentration of a particular constituent is elevated, "background" must first be defined. It is important to define "background" in NPRA because data for such a large area are limited. Of note, however, is the fact that the State of Alaska has not defined background limitations in soils except for Total Petroleum Hydrocarbons (TPH). In 1989 TPH was identified by the State to mean 10 mg/kg. On the North slope this number was recalculated to be 70(north slope value) + 10 (State identified background)= 80 mg/kg. By 1992, this background criteria had changed to 70(calculated north slope value) + 100 (new State standard)= 170 mg/kg. Presently there is no State standard for TPH.

Background concentrations can vary over large distances or there may be considerable local or on-site variability, which potentially can confound an interpretation of constituent transport at a single wellsite. Both broad scale and local variabilities in background concentrations were addressed in the 1990 sampling.

In order to consider areal variability, both within-site, and between-site variability in background chemical quality at wellsites, a sampling scheme was established for six of the ten 1990 wellsites. At each of these six wellsites, three samples were collected about 100 ft apart in each compass quadrant around the wellsite. Sampling sites were about one mile from the wellhead.

The reconnaissance of wellsites conducted in 1989 consisted of samples taken upslope, within, and downslope of the wellsites. In 1990, two wellsites were used to verify the validity of the reconnaissance sampling scheme used at all wellsites in 1989. East Simpson No. 2 and South Meade were gridded, and samples collected on the basis of the grids. The grid was established with measuring tape and theodolite, and the horizontal coordinates became the sample location identifier -- for example, N150 E300. A grid was established at

the sites oriented to the configuration of the reserve pit. Samples were collected at 50 foot intervals close to the reserve pit and at 100 foot intervals farther away.

DATA SUMMARIZATION AND RISK DETERMINATIONS

After assessment of the background information and evaluation of field data, a stepwise risk screening procedure was employed for each wellsite to determine if the contaminant concentrations provided a basis for environmental concerns. If there appeared to be a basis for concern, a determination was then made as to whether or not the risk appeared to be significant or negligible. Key factors used in this determination included exposure criteria, release mechanisms (leakage/seepage/erosion), contaminant migration, contaminant persistence, potential modifications to water quality, risk to fish and wildlife and their habitats, risk to human health, and aesthetics, both short and long term.

The review team's risk screening procedure was conducted similar to the process described in the State of Alaska's, "Interim Site Assessment Guidance for Inactive Drilling Waste Sites," published in June 1991 by the Alaska Department of Environmental Conservation.

This stepwise risk screening procedure begins with an initial step of determining if there was a basis of concern. If there was a basis of concern, then a determination was made of whether or not the risk was significant. Key criteria used to determine significance included exposure criteria, release mechanisms, contaminant migration and persistence, etc. The following State criteria established a basis of concern which states, "If the waste site has released contaminants or there are mechanisms for potential releases and there are receptors nearby, then there may be a cause for concern and the waste site should be studied further."

The State's Guidelines recommend determining if there is a basis for concern prior to examining additional risk screening criteria in order to determine if the overall risk to the environment and/or human health is either significant or negligible.

Similarly, this report has addressed these same criteria: release mechanisms, migration, persistence, and the potential risks to human, fish and wildlife habitats were all considered as a part of the assessment and risk screening process.

The study team designed a review process that utilized, in part, the State of Alaska Interim Guidance For Inactive Reserve Pits and other available information which was aggregated and itemized in a systematic and orderly manner using appropriate QA/QC controls for reference purposes for this report.

TABLE 1.

Wellsite	Site No.	Program	Physiographic Provence	Topographic Setting	Construction Material	Type of Pad	Dates of Drilling	Depth Drilled (in ft)	Depth Uppermost Cement Retainer (in ft)	Temperature Monitoring USGS - Geologic	Current Condition of Reserve Pit	Land Status	Elevation Difference Across Wellsite (in ft)	Water Quality Studies 1981 Tetra Tech	1983 USGS	1984 Duane	1989 USGS	1990 USGS	Remarks
Atigaru	4	Navy	Coastal Plain			Thick	1/13/77- 3/10/77	11,935	2,295	*	Backfilled	IC	6.99	No	No	No	Yes	No	Poor oil shows
Awuna	23	USGS	Southern Foothills	Site on slope underlain by colluvium with ice-rich permafrost within 1 ft of surface. Locally, ice 30 ft thick. Shale underlies colluvium.	From terrace deposits along Awuna River 1 mi N of site or from reserve pit.	Thick - Insulated	3/ 1/80- 5/ 3/80 12/ 5/80- 6/30/81	11,200	7,723	*	Open	Federal	17.83	No	No	Yes	Yes	No	Many gas shows; ice-rich permafrost and slope presented maintenance problems; drilled during two winters
Cape Halkett	1	Navy	Coastal Plain			Ice	3/24/75- 6/ 1/75	9,900	0		No pit, gas gravel berms knocked down	Federal	2.60	No	No	No	Yes	No	Dry
Drew Point	8	USGS	Coastal Plain	Site on low-lying area underlain by marine silt containing permafrost, permafrost within 2 ft of surface.	From reserve pit containing silt	Thick	1/13/78- 3/13/78	7,946	2,153	*	Backfilled	Federal	0.76	No	No	No	Yes	No	Poor oil and gas shows
East Simpson 01	16	USGS	Coastal Plain			Thin	2/19/79- 4/10/79	7,739	2,039	*	Open	Federal	3.00	No	No	No	Yes	No	Oil and gas shows
East Simpson 02	21	USGS	Coastal Plain	Site on flat-lying area underlain by marine silt containing permafrost; permafrost within 2 ft of surface; site in center of polygon	From shoreline of Smith Bay about 2 mi E or from the reserve pit containing silt	Thin	1/29/80- 3/15/80	7,905	1,977		Open	Federal	4.11	No	No	No	Yes	Yes	Oil and gas shows
East Teshekpuk	3	Navy	Coastal Plain			Thick	3/12/76- 5/11/76	10,464	2,520	*	Backfilled	Federal	2.35	No	Yes	Yes	Yes	Yes	Dry
Ikpikpuk	14	USGS	Coastal Plain	Site on reworked sand dune in low-lying swampy area underlain by colluvium silt and sand containing permafrost; within 1.5 ft of surface.	From ancient lakeshore containing silt and sand or from reserve pit containing silt	Thick	11/28/78- 4/17/79 12/26/79- 2/28/80	15,401	2,047	*	Partially Backfilled	Federal	13.89	No	No	Yes	Yes	Yes	Gas shows
Inigok	12	USGS	Coastal Plain (some relief)	Site on dune sand modified by lake action; permafrost within 1 ft of surface.		Thick Insulated	6/ 7/78- 5/22/79	20,102	60		Partially Backfilled	Federal	3.59	No	Yes	Yes	Yes	Yes	Northern Test Lab sampled in 1979, 1981, and 1982. Encountered hydrogen sulfide and sulfur at 17,570 ft; poor gas shows
J. W. Dalton	17	USGS	Coastal Plain	Site on flat-lying area underlain by marine silt with some sand.	From ancient bay mouth bar 3.5 mi NE of site	Thick	9/ 7/79- 8/ 1/79	8,367	1,500	*	Open	Federal	7.36	No	No	No	Yes	No	Oil and gas shows; some heavy oil recovered during testing
Kalubik	20	USGS	Northern Foothills	Site on terrace containing sand that has been modified by colluvium sand and silt; permafrost within 1.5 ft of surface.	Ample supply of material was obtained locally; with some gravel 1.5 mi NNW of site.	Thin	3/24/81- 4/19/81	5,882	1,600	*	Open	Federal	4.56	No	No	No	Yes	Yes	Gas shows and minor oil shows
Kugrua	16	USGS	Coastal Plain	Site on flat, poorly drained area underlain by lake sediments, overlying marine silt; permafrost within 1.5 ft of surface in ice-wedge polygons	Best source from terrace containing medium grained sand with some gravel about 1.5 mi NNW of site	Thick	2/12/78- 5/20/78	12,500	1,894	*	Open	Federal	5.92	No	No	Yes	Yes	No	Dry
Kuyanak	26	USGS	Coastal Plain	Site in abandoned lake, generally swampy; permafrost is within 1.5 ft of surface and, locally, is ice-rich	From reserve pit containing marine swampy lake sediments.	Thin	2/10/81- 3/31/81	6,600	4,464	*	Open	Federal	2.35	Yes	No	No	Yes	No	Minor gas and oil shows
Lisburne	18	USGS	Brooks Range	Site on dry moderately steep slope underlain by colluvium and glacial debris		Thick - Insulated	6/11/79- 6/ 2/80	17,000	1,840	*	Open	Regional Selection	78.39	No	No	Yes	Yes	No	Shows of gas
North Inigok	25	USGS	Coastal Plain (some relief)	Site on dune sand, about 100 ft wide and 0.5 mi long, that was once shoreline of ancient lake. Eolian sand is fine grained with ice-poor permafrost.	From local area or reserve pit consisting of fine-grained sand.	Thin	3/13/81- 4/ 6/81	10,170	8,160	*	Open	Federal	6.49	Yes	No	No	Yes	No	Shows of gas; upper 5 ft of permafrost is dry
North Kalikpik	11	USGS	Coastal Plain	Site on low-lying swampy area in old drained lake underlain by silt; permafrost is within 1 ft of surface	From borrow sites about 0.5 mi NE of site containing silty sands	Thick	3/27/78- 4/16/78	7,395	2,232	*	Backfilled	Federal	8.93	No	No	No	Yes	No	Poor oil and gas shows
Peard	15	USGS	Coastal Plain	Site on low-lying swampy area underlain by swamp debris that in turn is underlain by marine silt; permafrost is within 1 ft of surface	From Kugrua Bay about 0.5 mi NNW of site and from reserve pit which contains swamp debris	Thin	1/26/79- 4/13/79	10,225	2,026	*	Open	Federal	----	No	No	Yes	Yes	Yes	Poor gas shows
Seabee	19	USGS	Northern Foothills	Site on high, relatively dry, old Colville River terrace containing gravel; permafrost within 3 ft of surface		Thick - Insulated	7/ 1/79- 7/21/79 10/16/79- 6/15/80	15,611	1,400	*	Open	Federal	12.71	No	Yes	Yes	Yes	Yes	Oil and gas shows
South Barrieau	2	Navy	Coastal Plain			Thick	11/21/76- 2/ 9/77	11,290	2,250	*	Backfilled	IC	7.74	No	No	No	Yes	No	Poor oil shows
South Meade	9	USGS	Coastal Plain (some relief)	Site on old terrace of Meade River and is underlain by fine-grained sand containing permafrost	From terrace deposits at site containing fine-grained sand	Thick	2/ 7/78- 5/20/78 12/ 4/78- 1/22/79	9,945	1,975	*	Backfilled	Federal	10.05	No	Yes	Yes	Yes	Yes	Poor gas shows
South Simpson	7	Navy	Coastal Plain			Thick	3/ 8/77- 4/30/77	8,795	N/A		Backfilled	Federal	0.79	No	No	No	Yes	No	Dry
Tulugak	27	USGS	Coastal Plain	Site on flat-lying area underlain by marine silt containing ice-rich permafrost within 1 ft of the surface	From reserve pit containing ice-rich silt	Thin	2/26/81- 3/23/81	6,015	2,600	*	Open	Federal	2.23	Yes	No	Yes	Yes	No	Few poor oil shows
Tunalik	13	USGS	Coastal Plain	Site on relatively high area underlain by marine silts; permafrost within 1 ft of the surface		Thick - Insulated	11/10/78- 1/ 7/80	20,338	1,025	*	Open	Federal	7.86	No	Yes	Yes	Yes	Yes	Gas test; Northern Test Lab sampled in 1982
Walakpa 01	28	USGS	Coastal Plain	Site on flat-lying area underlain by marine silt containing permafrost; permafrost within 10 in of the surface	From reserve pit containing silt	Thin	12/25/79- 2 7/80	3,600	1,400		Open	IC	1.20	No	No	Yes	Yes	No	Shows of gas
Walakpa 02	24	USGS	Coastal Plain	Site on low-lying swampy area with polygons and underlain by frozen marine silt, locally sandy; permafrost within 10 in of the surface	From reserve pit containing silt	Thin	1/ 3 81- 2/19/81	4,300	3,610		Open	IC	2.73	Yes	No	No	Yes	No	Temporarily abandoned (gas well - Walakpa sand)
West Dease	22	USGS	Coastal Plain	Site on old drained lake in low-lying swampy area; permafrost within 9 in of surface	From reserve pit containing silt	Thin	2/10/80- 3/26/80	4,015	2,700	*	Open	Federal	2.31	No	No	Yes	Yes	No	Oil and gas shows
West Fish Creek	5	Navy	Coastal Plain			Thick	2/14/77- 4/27/77	11,427	2,400	*	Backfilled	Federal	0.14	No	No	No	Yes	No	Poor oil shows
W. T. Foran	6	Navy	Coastal Plain			Thick	3/ 7/77- 4/24/77	8,004	N/A		Backfilled (reworked by Chevron)	IC	3.26	No	No	No	Yes	No	Oil and gas shows; Chevron drilled a directional well - 'Live Horse'

IC - Interim Conveyance to Regional or Village Corporation
Federal - Federally held land
Regional Selection - Land is Federal with Regional Corporation Selection filed

Navy EA - 1975 Navy Environmental Assessment
Navy EIS - 1977 Navy Environmental Impact Statement
USGS EA - USGS Individual Site Environmental Assessment, referencing the Navy EIS

In the initial Plan of Study, only very broad filters were expected to be used to screen the data and information. However, the data were so comprehensive and focused that they allowed more rigorous analysis reflecting the uniqueness of the NPRA environment, Arctic climate and permafrost setting.

Initial considerations included the following: 1) current state of the site; 2) interaction of site with surrounding habitats; 3) interaction with resident or migratory waterfowl or animal communities; 4) interaction with resident or seasonal human populations; 5) original conditions set by the programmatic environmental impact statement and individual site environmental assessment; 6) Congressional acts which were passed after exploration began and before exploration was completed; 7) coordination with the State of Alaska; and 8) other Departmental considerations.

Table 2. lists the Maximum Contaminant Level (MCL) allowed in drinking water as promulgated by the USEPA. This was the standard used for evaluation of water samples. Initially the MCL data used was for 1989. By 1992, many of the MCLs had changed. In the analysis found in the Appendix section for wellsites, changes in MCLs are note as they impact the risk determination.

Table 2 Water Constituents Criteria

Constituents	1989 MCLs	1992 MCLs
Arsenic	0.05	0.05
Barium	1.0	2.0
Beryllium	0.01	0
Chromium	1	1
Hexavalent	0.05	0.05
Trivalent	0.05	0.05
Copper	treatment technique	1.3 mg/l in tap water
Fluorite	4.0	4.0
Lead	0.05	treatment technique
Mercury	0.002	0.002
Nitrate plus Nitrite	10	10
Sulfate	500	-
Chloroform	100	100
Benzene	5	5
Tricloroethane	200	200
Vinyl Chloride	2	2
Trichloroethylene	5	5
Dichlorobenzene	600	600
Xylenes	10000	10000
Toluene	1000	1000

Definition for the terms used in determination of wellsite risks are provided in Table 4; the definitions for subjective criteria used in the evaluations appear in Table 5, and are based on the review teams scientific professional judgment criteria to evaluate site risks.

Each wellsite evaluation (see Appendix A) includes a "Wellsite Risk Determination" summary (i.e. Table A-1). These were prepared by the review team to address site observations and determine risk screening.

FINDINGS

An interdisciplinary BLM and USGS team assembled, reviewed and analyzed pertinent data on each of 28 exploratory wellsites. Multi-year sample data were available for chemical constituent concentrations: within reserve, flare and fuel storage pits; on the camp and drilling pads; at points generally 50 and 200 feet downslope and 200 feet upslope from the pads and pits; 50 feet downslope of a leak in the reserve pit containment berm; in areas of stressed vegetation; and where field measurements were high. The team, using published data, professional scientific judgment and significant professional experience, evaluated constituent concentrations relative to: drinking water standards; Alaska soil criteria; mobility and persistence within and away from the site; effects and potential effects on the natural ecosystem; and potential hazards to human and wildlife use.

These evaluations led to risk screening and a team determination of risk at each site. This report establishes status of sites. It provide a means to summarize present physical and chemical conditions and their impact on the environment. This report should provide a sound basis for management decisions and future management strategies for each site.

The majority of the 28 wellsites fall into two categories of pad and pit construction: thick or thin depending on the drilling requirements at that site. Thick pads consist of sand and gravels usually acquired off-site. Some of the pad material was pushed back into the pits on ten of the sites to partially or fully cover the drilling muds and cuttings in a pit . Leveling and reshaping of the pad was to help blend the site into the surrounding area. Material was pushed into the pits with the expectation that it would encapsulate muds and cuttings, thereby reducing their mobility into the surrounding environment and contact with potential bioreceptors. The amount of material and timing (end of summer season) used to back-fill pits did not initiate freeze-back of pits and contents. Instead, residual ponds replicating the shape of original pits formed as underlying ice-rich materials melted.

Thin pads were constructed primarily from materials excavated from pits. These materials were commonly ice rich silts used to level the rig and camp area

which sustained a single winter season of drilling. Pits at these sites (11) were not back-filled. Some thin pads were reshaped upon site abandonment, but remnants of silts from which ice has melted remain adjacent to the pits. Drilling muds and cutting in these pits are in direct contact with overlying water and in most cases the pit and water depths are greater than those associated with thick pads with back-filled pits.

The Team found that the mobility of mud and cutting constituents was extremely limited for both open and back-filled pits. Hydrocarbons and other drilling mud constituents such as chromium and barium are highly immobilized due to their strong affinity for fine hydrated particles in drilling muds, as well as, naturally occurring organic rich soils. In addition, most pits are continuing to subside through natural processes. As these muds and cuttings subside below their original level into the permafrost layer, they should become even less mobile as though in their own separate containers. Those limited constituents that are leaching into overlying water appear to be diluted rapidly to below criteria levels upon leaving the site (within 200 feet of the pit or pad).

These wellsites have little to no basis for concern due to: limited areal extent; low contaminant concentrations and/or mobility; and/or potential to impact human and wildlife use.

Table 3. SUMMARY OF RISK DETERMINATION FOR EACH WELL SITE AREA OF OPERATION

WELLSITE AREA OF OPERATION	RISK DETERMINATION
ATIGARU POINT	No basis for concern
AWUNA	Negligible
CAPE HALKETT	Negligible
DREW POINT	Negligible
EAST SIMPSON #1	Negligible
EAST SIMPSON #2	Negligible
EAST TESHEKPUK	Negligible
IKPIKPUK	Negligible
INIGOK	Negligible
J.W. DALTON	No basis for concern
KOLUKTAK	Negligible
KUGRUA	No basis for concern
KUYANAK	Negligible
LISBURNE	Negligible
NORTH INIGOK	No basis for concern
NORTH KALIKPIK	No basis for concern
PEARD	Negligible
SEABEE	Negligible

SOUTH HARRISON	Negligible
SOUTH MEADE	Negligible
SOUTH SIMPSON	Negligible
TULAGEAK	No basis for concern
TUNALIK	Negligible
WALAKPA #1	No basis for concern
WALAKPA #2	Negligible
WEST DEASE	Negligible
WEST FISH CREEK	Negligible
W.T.. FORAN	Negligible

DISCUSSION

DRILLING MUD DISPOSAL

The approach used in the disposal of drilling mud and well cuttings on the National Petroleum Reserve in Alaska (NPRA) has evolved as scientific information, drilling experience in permafrost areas, and a greater appreciation of the Arctic environment have increased. Originally the muds and cuttings were exhausted directly to the tundra surface where they often created operational hazards, the contamination of surface water was a possibility, and the mud created an aesthetically displeasing appearance until natural revegetation occurred. The advantages were that rapid dilution of any contaminants could occur and the muds tended to leave little evidence of surface disturbance over the longer term.

Bermed reserve pits dug into the permafrost for the emergency containment of well-upset or blowout materials offered superior mud containment. The resulting combined reserve (mud) pits became the standard, with the depth of the excavation being so designed as to provide containment of all of the anticipated mud and cuttings below the level of the permafrost table. The portion of the pit above the permafrost table, combined with the height of the surrounding berm, was intended to provide containment for any emergency well-upset or blowout material. Upon completion of drilling, mud and cuttings were contained by the surrounding permafrost, the usefulness of the berms for blowout protection was at an end, and it only remained to determine the most environmentally acceptable procedure to expedite the return of the wellsite area to compatibility with the surrounding landscape.

Water, rock cuttings, barium sulfate, and bentonitic clay, all of them naturally occurring materials, make up 99 percent of most drilling mud. Non-toxic fibrous materials, such as ground-up walnut shells; soluble salts; and petroleum-based products, which may have toxicity in certain concentrations, make up about one

percent. Because the physical and chemical properties of the substrata change with depth, and from one well to another, corresponding changes in the composition of drilling mud are required to maintain its functions. Generally, however, the muds will contain sufficient caustic soda (NaOH) to maintain the pH in the 9.0 to 11.0 range, and sufficient barium sulfate ($BaSO_4$) to maintain a mud weight of 9 to 12 pounds per gallon (specific gravity 1.1 to 1.5) although, when high pressure natural gas is encountered, the mud may be weighted up to as much as 18.5 pounds per gallon (specific gravity of 2.3). Bentonitic clays are used as a suspension medium to carry cuttings to the surface.

Sand and gravel from the adjacent drilling pad and berms were used to cover drilling mud and pits at the first wellsites rehabilitated. The lowered pad and the covered reserve, flare and fuel pits were then contoured, the surface seeded with Arctic grasses and commercial fertilizer was applied. The assumption was that the mud would be immobilized within the permafrost and that new grasses would stabilize the surface materials until the area could revegetate naturally. However, the containment assumption proved to be in error because the filled-in pit areas settled as the ice-rich permafrost underlying the pits continued to thaw, whether covered during the winter or during summer. This resulted in the formation of shallow ponds in the former reserve pit areas, forcing the brines in the drilling muds nearer to the surface.

The reserve pits at the later wellsites were left uncovered. Those pits tended to deepen, and the mud settled as the underlying ice wedges and ice-rich mineral soils continued to thaw. Some pits, originally dug to a depth of 5 feet into the permafrost, were 9 to 11 feet deep when measured in 1989 and 1990. The winter freezing processes concentrate the salts in the lower portions of the deeper pits and even to "drive" the salts into the muds wherever the pits freeze to the bottom. The low-density bentonitic clays in the upper portion of the mud also tend to act as a "cap" on the heavier mud components and the cuttings.

The presence of the ice cover on the pits during the spring runoff period provides a barrier between the runoff and the brines and prevents flushing from the pits; the higher density of the brines keep them on the bottom during the runoff following summer precipitation. Thawing of ice wedges abutting the pits, and the ensuing slumping of the overlying mineral soils and tundra cover, gradually provides an irregular outline for the pit thus helping them blend into the natural landscape.

CONTAMINANT MOBILITY AND PERSISTENCE

Drilling for oil provides an opportunity for contaminants to be introduced into the environment. The relative hazard of the contaminants depends on the toxicity and amount of the material. Drilling wastes include drilling mud and well cuttings. Drilling mud serves as a lubricant, a suspension medium and a weighting and packing material. As a lubricant, it removes rock particles and

heat from the drilling bit area. As a packing material, the weight of the drilling mud provides backpressure to keep fluids (oil, gas, water) from moving up-hole. The drilling mud is continually recycled through the bore hole, over the shaker screens to separate out the coarse material and into the mud tanks for reuse. Fine drill cuttings become a part of the drilling mud, and as such may be used to increase the density.

Bentonite is a clay mineral (montmorillonite and related minerals) that is non-toxic and chemically inert, but with a great capacity for ion exchange including adsorbing heavy metal ions. It has great swelling properties and particles become highly dispersed in water, especially in water with a basic pH such as in a drilling mud. As a component of drilling mud, bentonite is a lubricant and packing material and under some conditions it becomes a gel. It is also used as a liner of waste disposal pits, oilfield pits, and landfill sites to keep liquids from migrating from the site, and to adsorb metals and other compounds that occur in the liquids. Bentonite has one of the highest capacities for adsorbing potentially toxic compounds of any known natural and anthropogenic material. It is widely used as a filler in prepared foodstuffs for humans and animals.

Barite is an inert mineral composed of barium and sulfate, and naturally occurring on the NPRA. With its high specific gravity of (4.3-4.7) barite is used to increase the density of drilling muds when "over pressuring" is encountered at depth while drilling a well. Having a very low solubility, barite is immobile in the natural environment. Because of it's inert and dense qualities, finely powdered barite is commonly ingested before an X-ray examination of the gastrointestinal tract. Barite is a principal constituent of drilling mud, sometimes reaching 70 percent by volume of the mud.

Small amounts of other compounds are sometimes added to change the viscosity of drilling mud as special needs arise. One of these compounds, which serves as a dispersant, is a chromium-lignosulfonate. In the natural environment, chromium occurs primarily as the insoluble mineral chromite, as in bottom sediments. Dissolved chromium generally occurs in the highly mobile, but unstable, hexavalent form. Hexavalent chromium is generally considered to be of anthropogenic origin; however, there are reports of natural occurrences of hexavalent chromium in nature. In order to determine the degree of chromium contamination in the environment, determined values must be compared with the amount of chromium that occurs naturally in the environment. In a study of the background geochemistry of bottom sediment in lakes and rivers in Alaska, Weaver identified the North Slope west of the Colville River as having unusually elevated amounts of naturally occurring chromium. The naturally occurring high background concentrations of chromium in NPRA need to be considered when assessing potential chromium contamination of an area.

However, irrespective of the valence state of chromium (trivalent or hexavalent), chromium would appear to be an insignificant contaminant because of the

elevated pH (>8) of the drilling fluids. The chromium would be precipitated and associated with sediment and would therefore be immobile unless moved. In both valence states, the chromium ions are strongly bonded to the sediment and are not available.

Compounds, such as sodium hydroxide, are occasionally added to drilling muds. In the NPRA, this is indicated by the very high pH (>8) of the reserve pit water. In these cases, the high pH causes the precipitation of chromium and other potentially toxic trace metals as hydroxides or other immobile compounds. These compounds are highly stable, effectively removing the metals from solution as they settle to the bottom of the pit.

Drilling waste includes finely ground rock debris from the bore hole and drilling mud and is largely confined to reserve pits constructed at each wellsite. As the site returns to its natural state through normal geomorphic, hydrologic and vegetative processes, particularly the effect of permafrost, dispersion of the drilling wastes in the reserve pit to the surrounding area may occur. In the Arctic, these processes are likely to occur very slowly. The impact on the environment depends on both the toxicity and amount of the contaminants. In the case of drilling mud, the two principal constituents, barite and bentonite, are chemically benign. The presence of bentonite will probably substantially reduce the rate of dispersal of potentially toxic constituents to the environment. As the source of potential contaminants is finite and relatively small, it is limited to the amount of drilling mud used in the well, and the amount of rock drilled from the well. Eventual dispersion of any contamination in the area will be lost by dilution.

DRILLING PAD AND RESERVE PIT DESIGN AND CONSTRUCTION

The experience gained from the Navy's pioneering program in northern Alaska during 1945 - 1953 suggested that gravel or sand pads would be required in this cold permafrost area, both for operational efficiencies and short-term environmental acceptability, during any new exploratory drilling programs on the National Petroleum Reserve in Alaska (NPRA).

The depth to the permafrost table (top of permafrost) ranges from 1 foot, in wet sphagnum covered areas to about 4 feet, in dry sandy areas. While the maximum known thickness of the permafrost on the NPRA, found 13 km south of Barrow, is about 400 m, it is the ice-rich uppermost 5 or 6 m that most heavily influences the design of drilling pads and reserve pits, as well as the methods employed and the timing for the overland transportation of equipment and supplies. The ice in the upper 5 or 6 m may be in the form of ice crystals within the mineral soils or, more importantly, as segregated ice, in the form of ice wedges, whose surface expression forms the polygonal patterning observed so prominently in

Arctic tundra areas. The ice wedges, which may be 2 to 3 m wide at the top and extend in pie-shaped fashion to depths of 5 to 6 m, are found beneath the shallow, interconnected troughs surrounding the polygons, which usually vary in diameter from about 5 to 30 m.

Whenever the tundra is compressed, ripped up, or removed, the annual depth of thaw is increased, because of the reduction or elimination of the insulative effects of the living and accumulated dead plant materials. The thawing is deeper and the resulting differential settlement is greatest in the trough areas, where ponding will occur in the absence of a previously-established drainage system. Where a gradient exists the trough areas will continue to slump into the void created as the melted ice drains away during the succeeding summers, and the thermo-erosion and differential settlement will move upslope and into less disturbed or even undisturbed areas.

Digging a reserve pit into the permafrost removes the upper portion of the underlying ice wedges and cuts the wedges intersecting the sides of the pit exposing both to the thawing process. If the pit is constructed during the late winter, in order to be able to begin drilling early the following winter, thawing and settlement will take place during the intervening summer further deepening the pit. This tendency, toward development of a "thawing bulb" beneath the bottoms of pits, was also evident at a number of the wellsite reserve pits which, after receiving the muds and cuttings from drilling, had measured water depths significantly greater than the original dug depths of the pits. The thawing of the intersecting ice wedges at the sides of the pits is evidenced where the slumping of the overlying mineral soils, including those in the berms, has resulted in small embayments blurring the original, regular outlines of the pits.

The advantages and disadvantages of the thick (5-foot), thin (2-foot), and the insulated thin pads used during the exploration of the National Petroleum Reserve in Alaska were discussed in the Final Environmental Impact Statement (FEIS)for NPR-4 (Zone A) (October 1975), and repeated in the 27 May 1977 FEIS for the entirety of the NPR-4 (renamed the NPRA).

A 5-foot thickness of sand or gravel provides sufficient insulation to cause the permafrost table to rise into the lower portion of the fill on the coastal plain in northern Alaska. Two inches of high density (HI-60) Styrofoam insulation, overlying a thin leveling course of sand and gravel and covered by 18 inches of gravel to provide for the distribution of weight as well as a trafficable surface, are sufficient to cause the permafrost table to rise into the base of the insulation. Both designs provide a firm, stable foundation for year-round exploratory drilling, or for long-term operations such as are involved in the development and production of an oilfield.

The major disadvantages are that the thick pad construction involves the opening of a material site, often at some distance, the hauling of 30-40,000 cubic yards of

sand and gravel over the tundra and, unless the pad thickness is reduced by using much of the pad material to fill or partially fill the reserve pit after completion of drilling, the pad tends to remain an unvegetated or only partially vegetated sandy patch on the landscape for many decades. While an insulated thin pad is usually more amenable for revegetation because plant roots can have easier access to moisture and the surface is less exposed to wind, the hauling of 10-15,000 cubic yards of sand and gravel from a material site is still required. Options for rehabilitation also are limited since it is virtually impossible to separate the adhering sand and gravel from the insulation, or plastic coverings in winter. If that type of wellsite rehabilitation is attempted during the summer thaw period, the potential damage to the surrounding tundra from the equipment employed is greatly magnified and the usual result is an environmental morass.

An advantages of the thin (2-foot thick) pad design is that the material removed to provide the reserve and flare pits is sufficient to level the drilling and camp areas. This provides a frozen stable foundation for winter-only drilling operations, eliminating the requirement to haul sand and gravel from a distant material site. During the following summers, the insulative value of the 2 feet of settled, formerly ice-rich material tends to approximate that of the covered and now compressed tundra layer, thus causing little long-term modification of the pre-existing hydrologic and permafrost processes. A formerly low-center polygonal area gradually develops ponded, low-centered areas; a formerly high-center polygonal area gradually develops its former thermokarst-type topography; becomes vegetated naturally with its characteristic plant assemblages, since the soil moisture regime and the relative surface elevations are little altered; and the area gradually blends into the surrounding landscape. The cost of construction for the thin pad design is approximately one-third that of a thick pad or of an insulated thin pad. The disadvantages of the thin pad design are that it provides a firm foundation only during the winter period (8 months on the NPRA) and, because the surface is not elevated significantly above the surroundings, the winds are less successful in keeping the pad operating area relatively free of drifted snow.

NOTES ON REVEGETATION

Revegetation, including seeding and fertilizing, was accomplished on all of the pads and the program is identified in the specific wellsite data tables. Some efforts were more successful than others because our understanding of revegetation, plant seeds and heavy metals in the arctic increased.

Initially, attention focused on the heavy metals in the natural environment as well as in drilling muds as a reason for plant mortality since high concentrations of some of these elements are fatal to plants. However, data obtained on water and mud collected from reserve pits and from other studies indicate the pH levels in those pits are high, rendering all heavy metals, except molybdenum,

weakly soluble and biologically unavailable. For instance, barium sulfate, a common component used to increase the specific weight of drilling muds, is quite insoluble in water.

In one study by McKendrick, it was observed that the background levels for available barium in soils at more than 50 locations sampled in the Prudhoe Bay region ranged between 3 and 78 ppm (parts per million) and averaged 28 ppm. In comparison, 13 samples of reserve pit muds contained less than 30 ppm available barium. Interestingly, the highest level of available barium (nearly 90 ppm) was in sediments from a natural lake in the foothills of the Brooks Range. That lake is many miles from any source of drilling mud, and contains barium entirely from natural rock sources. Therefore, it could be concluded that heavy metals are not killing the tundra plants. Rather, it is salt (sodium chloride) that is more likely for stresses vegetation. Sodium ions are used to disperse the clays so that they will remain is suspension during the drilling process. High concentrations sodium and chloride ions in soil reduce water availability to root plants, and can also disrupt soil structure and reduce aeration. Instead of heavy metals, the damage to plant life comes primarily from physiological drought induced by salt, and this is noted along the coastal area where salts build up through evaporation or are wind driven from the ocean.

Exhaustive studies indicate that natural vegetation works well when supplemented by initial revegetation efforts. Mckendrick(University of Alaska) states that at Tunalik and other NPRA drilling sites, "we have a record of when the site was constructed, how it was used, when it was abandoned, which species of plants were seeded, the amount of fertilizer applied, and how seeding and fertilizing occurred. As a result, we can examine and evaluate plant communities knowing the various construction and repair practices used. We can determine long term implications of land rehabilitation practices at the site. What do these observations indicate for tundra rehabilitation? They show that seeding with a mixture of native grasses adapted to the tundra and available from commercial growers can produce vegetation on gravel pads".

The early efforts spent on revegetation of these 28 sites used information from the Trans-Alaska Pipeline which was a significant learning experience and which provided a baseline for further efforts. The constant learning and implementation of new knowledge and skills has rapidly evolved although the overall strategy of initial seeding and fertilizing and the natural recurrence and recovery of native plants appears to be quite sound.

Table 4. Definition of Headings on "Wellsite Risk Determination" Forms

WELLSITE CHARACTERISTICS: -- these characteristics pertain to the area used for drilling the well and support functions. Areas include the pad, reserve pit, flare pit, and sometimes a fuel pit.

Sampling History -- identification of sampling by various entities.

Prior Mitigation -- actions taken after drilling to rehabilitate the site. These actions may include filling of reserve and flare pits with local or pad material, and grading of the site. In some cases, the berms were also graded. After grading, all pads and sometimes the pits were seeded and fertilized. The years that the seeding and fertilizing took place are indicated.

Leakage and Seepage -- movement of water through berms surrounding the reserve, flare, or fuel pits.

Erosion -- movement of berm, pad, or graded material into the surrounding area.

Subsidence -- the decrease in elevation of the bottom of the reserve, flare or fuel pits, berms or pad, or berm heights commonly due to the melting of underlying permafrost and ice wedges.

Natural Processes -- the normal geologic and hydrologic actions responsible for the surficial characteristics of the wellsite. In polar regions, the most important processes are the differential settlement and heaving associated with permafrost.

GENERAL SITE CHARACTERISTICS: -- these characteristics pertain to the wellsite and the surrounding area.

Vegetation -- this term includes both natural and seeded plant growth.

Natural Processes -- the normal hydrologic and thermal actions responsible for the surficial expression of the general site and surrounding area.

WASTE: -- this term includes all materials remaining at a wellsite after cleanup from the drilling operations.

Drilling -- drilling waste includes drilling muds and drill cuttings. Drilling mud is almost totally composed of naturally occurring bentonite clay, water, barium sulfate, and rock cuttings.

Other Solids -- this term includes any man-made solid material left at the wellsite other than drilling waste; for example, barrels, cables, and trash.

Hydrocarbon Residue -- this term pertains to produced hydrocarbons or manufactured petroleum products left at the wellsite.

Contaminant Level -- the highest measured concentration of chemical constituents introduced at the wellsite and compared to drinking water standards(MCL) and background criteria for sediment and soil.

Contaminant Migration -- the observed and predicted movement of contaminants associated with water, sediment, or soil.

Contaminant Persistence - age of pit/pad relative to current contamination and resistance to biological degradation, mineralization and photosynthesis

RISK SCREENING: -- evaluation of all factors affecting humans, plant and wildlife at the wellsite and in the immediate area.

Risk to Fish and Wildlife -- the projected degree to which contaminants could adversely impact fish and/or wildlife.

Risk to Humans -- the projected degree to which contaminants could adversely impact humans.

RISK DETERMINATION: -- the risk determination is the evaluation process resulting in assigning a relative concern for the plants, animals and for public welfare of the humans that might visit the wellsite and surrounding area, based upon professional scientific judgment and sample data. (see Table 4 for definitions used in this evaluation process)

Table 5 Definition of the Evaluation Criteria for Waste Concentrations and Risk Screening/Determination.

WASTE CONCENTRATIONS

Background -- the naturally occurring concentration of a constituent determined by an analysis of variance statistical test (USGS Open File Report 91-458) on an entire data set, data for a single site, and data within the gradients for each site.

Elevated -- the concentration of a constituent that exceeds an MCL (maximum contaminant level set by USEPA) and/or in some cases exceeds background values .

Highly Elevated -- the concentration of a constituent that exceeds an MCL or background value by more than two orders of magnitude.

RISK SCREENING/DETERMINATION

No Basis for Concern -- where the concentration of drilling constituents and/or waste are equal to or less than water quality standards and/or background and professional scientific judgment concludes that a problem does not exist.

Negligible -- where the concentration of drilling constituents and/or waste are greater than water quality standards and/or background; and concentrations were elevated to highly elevated, constituent mobility and biota accessibility were limited. Where elevated concentrations are found in a remote site reserve pit or drilling pad, and professional scientific judgment concluded that adverse impacts are unlikely.

Significant --the concentration of drilling constituents and/or waste may be elevated or even highly elevated and may be accessible to wildlife and humans, and professional scientific judgment concluded that adverse impacts are likely to occur.

In 1991, MCL's were defined by the Environmental Protection Agency to mean-Enforceable, health-based regulation set as close to the MCLG(Maximum Contaminant Level Goal) as is feasible. Feasible means the use of best technology, treatment techniques, and other means that the administrator of the USEPA finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are generally available, (taking cost into consideration.)
MCLG is defined as -Recommended but not enforceable health goals that is to be set at the level at which no known or anticipated adverse effects on the health of persons occur and that allows an adequate margin of safety.

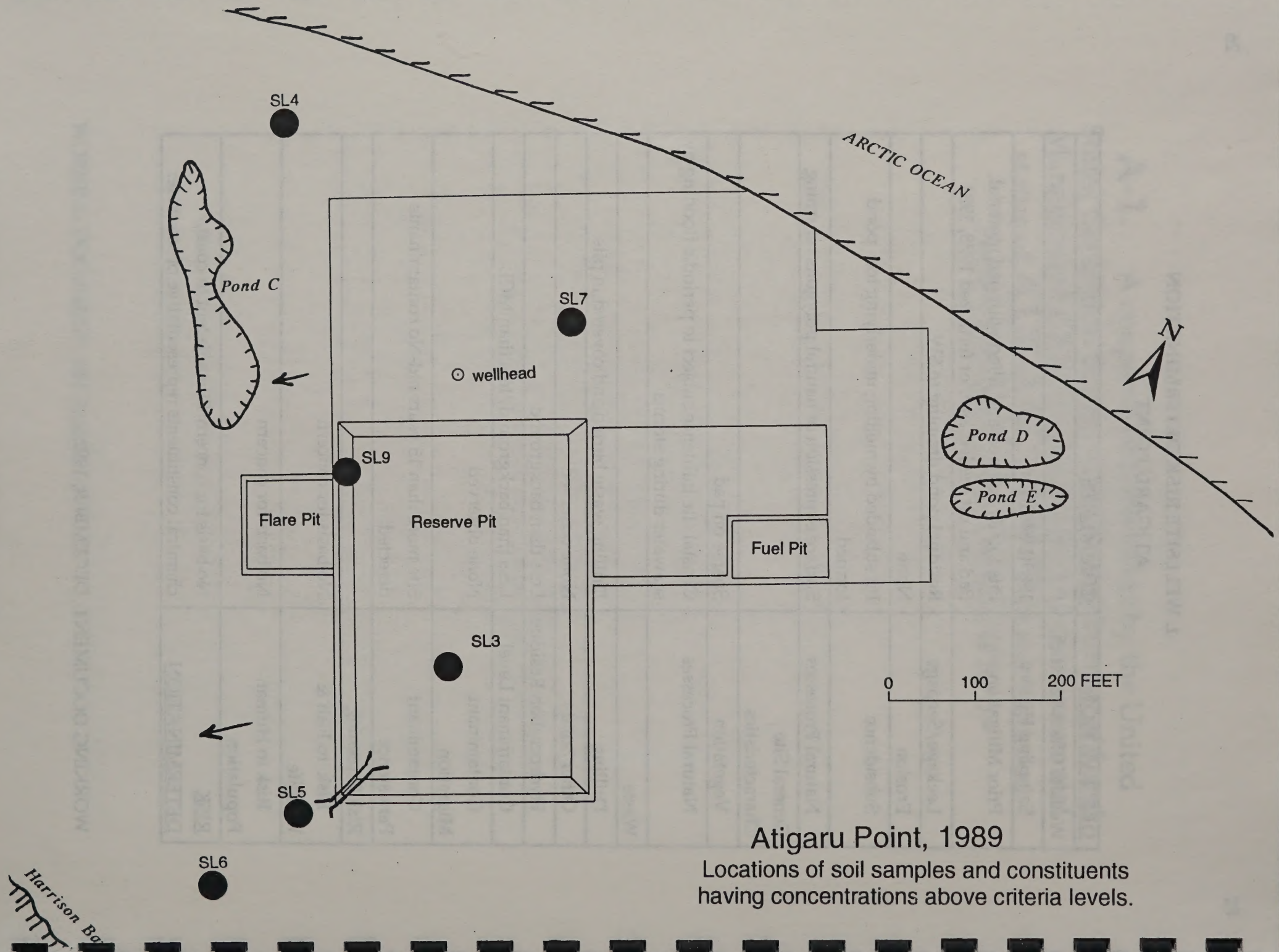
APPENDIX A
(28 WELLSITES)

Poor Mitigation	Site totally covered and filled with pad material. Pad and pit seeded and/or fertilized 1978, 1981
Leakage/Seepage	Residual pond draining to SW
Erosion	None
Subsidence	Pit subsided by melting underlying ice; pond formed
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Sparse on pad
Natural Processes	Coastal site influence subject to periodic flooding by seawater during storms
Waste	
Drilling	Drilling waste buried and covered in pits
Other Solids	None observed
Hydrocarbon Residue	Less than background
Contaminant Level	Less than background/less than MCL
Contaminant Migration	None observed
Contaminant Persistency	Site more than 15 years old-No contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	No basis for concern
Risk to Human Population	No basis for concern
RISK DETERMINATION	No basis for concern: Site adjacent to coast, chemical constituents representative of sea water

A-1. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of ATIGARU POINT in the National Petroleum Reserve in Alaska (NPRA).

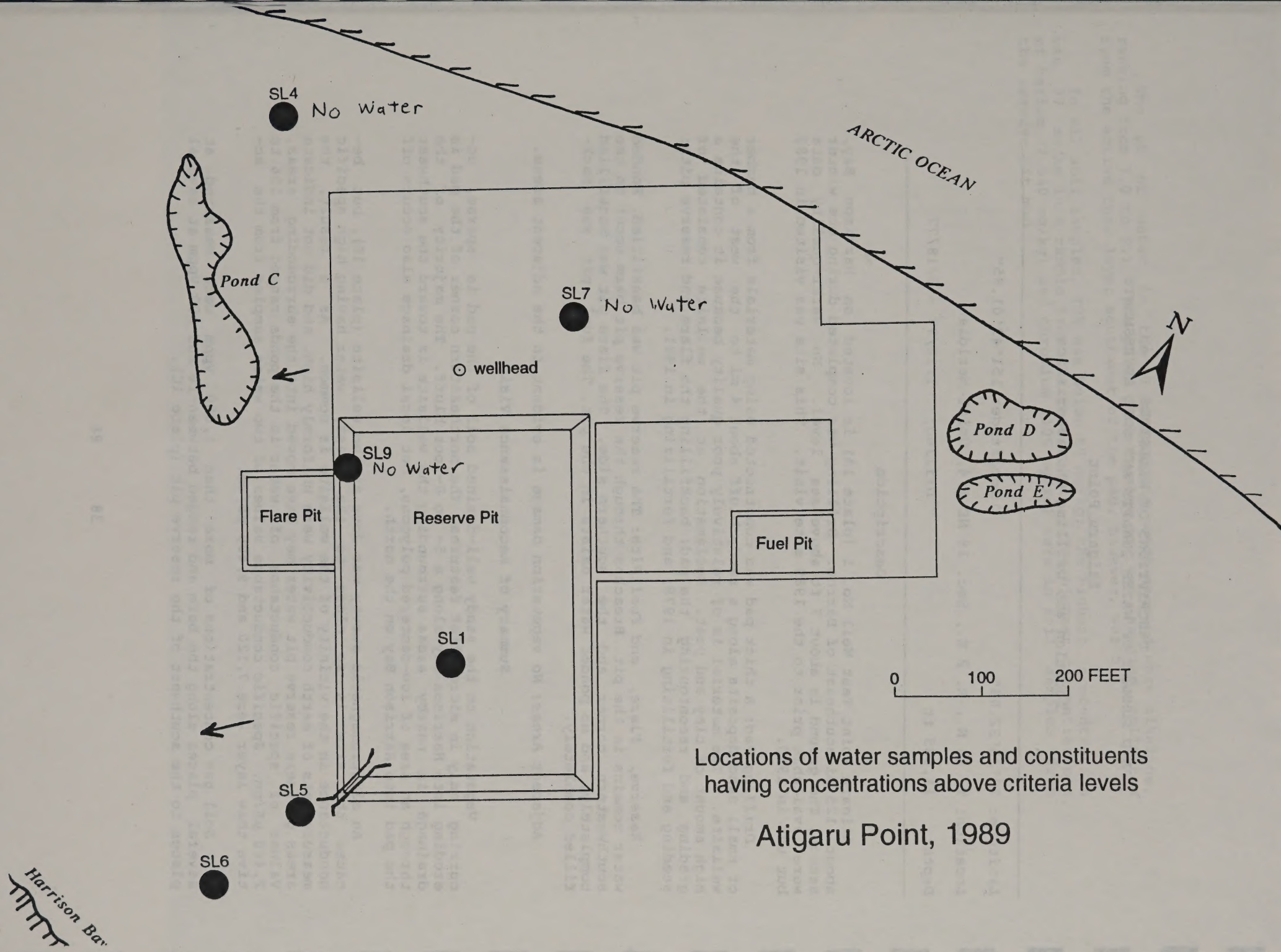
1. WELLSITE RISK DETERMINATION
ATIGARU POINT

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Pits totally covered and filled with pad material. Pad and pit seeded and/or fertilized 1978, 1981
Leakage/Seepage	Residual pond draining to SW
Erosion	None
Subsidence	Pit subsided by melting underlying ice; pond formed
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Sparse on pad
Natural Processes	Coastal site influence subject to periodic flooding by seawater during storms
Waste	
Drilling	Drilling waste buried and covered in pits
Other Solids	None observed
Hydrocarbon Residue	Less than background
Contaminant Level	Less than background/less than MCL
Contaminant Migration	None observed
Contaminant Persistence	Site more than 15 years old-No contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	No basis for concern
Risk to Human Population	No basis for concern
RISK DETERMINATION	No basis for concern: Site adjacent to coast, chemical constituents representative of sea water



Atigaru Point, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



Locations of water samples and constituents having concentrations above criteria levels

Atigaru Point, 1989

DESCRIPTIONS OF WELLSITES
AND SUMMARY OF WATER QUALITY AND SOIL ASSESSMENTS

Atigaru Point

Location and Drilling Characteristics

Latitude: 70°33′22.03" *Longitude*: 151°43′01.85"

Location: T. 14 N., R. 2 E., Sec. 19 NE 1/4, Umiat Meridian

Depth: 11,535 ft *Drilled*: 1/12/77 - 3/18/77

Description

Atigaru Point Test Well No. 1 (plate 1A) is located on Harrison Bay, about 125 mi southeast of Barrow. Drilling was completed during one winter season. The ground is about 7 ft above sea level. No water-quality data were available prior to the 1989 site visit. This site was visited in 1989 but not in 1990.

Drilling Pad: A thick pad was constructed using materials from a number of small sand deposits along a sandy bluff about 4 mi to the west of the wellsite. The material is of relatively poor quality because it contains a high amount of clay and peat. Reclamation at the wellsite consisted of grading and recontouring the pad; backfilling the flare and reserve pits; seeding and fertilizing in 1978; and fertilizing in 1981.

Reserve, Flare, and Fuel Pits: The reserve pit was backfilled. Ponded water remains in the pit. Breaches through the reserve pit berm occur on the southwestern corner and the southern side. The flare pit was backfilled completely, and no ponded water exists in the pit. The fuel pit was backfilled completely.

Adjacent Areas: No vegetation damage is evident in the adjacent areas.

Summary of Reconnaissance Visit

Vegetation on the sandy well-drained soil of the pad is sparse, occurring only in microrelief features. The northeastern corner of the pad is eroding into Harrison Bay along a 5- to 8-foot bluff. The majority of the drainage in nearby areas surrounding the wellsite is toward the southwest through an area of low-centered polygons, but local drainage also occurs off the pad into Harrison Bay on the north.

An electromagnetic survey was done at the wellsite (plate 1B), but because the site is so close to the coast, water having high specific conductance in the vicinity of the wellsite is common. As a result, the measurements of earth conductivity were uniformly high, and did not indicate areas of where reserve pit water may have moved into the surrounding areas. Values of specific conductance of water in the ponds ranged from 156 to 2,460 µS/cm. Specific conductance values of two water samples from the active thaw layer were 7,120 and 9,400 µS/cm.

Soil gas concentrations of more than 1,000 Vppm were measured at several places along the berm and ranged between 16 and 200 Vppm at several places to the southwest of the reserve pit (plate 1C).

The pH of water in the 10 surrounding ponds sampled were alkaline, ranging from 7.0 to 9.1. The pH of ground water in two samples collected from the active thaw layer southwest of the pad, however, was 5.6.

In all soil samples, TPH was below 80 mg/kg; the highest concentration was 77 mg/kg in a sample from the reserve pit. The highest concentrations of barium (2,540 mg/kg) and chromium (105 mg/kg) were in soil samples from the reserve pit mud.

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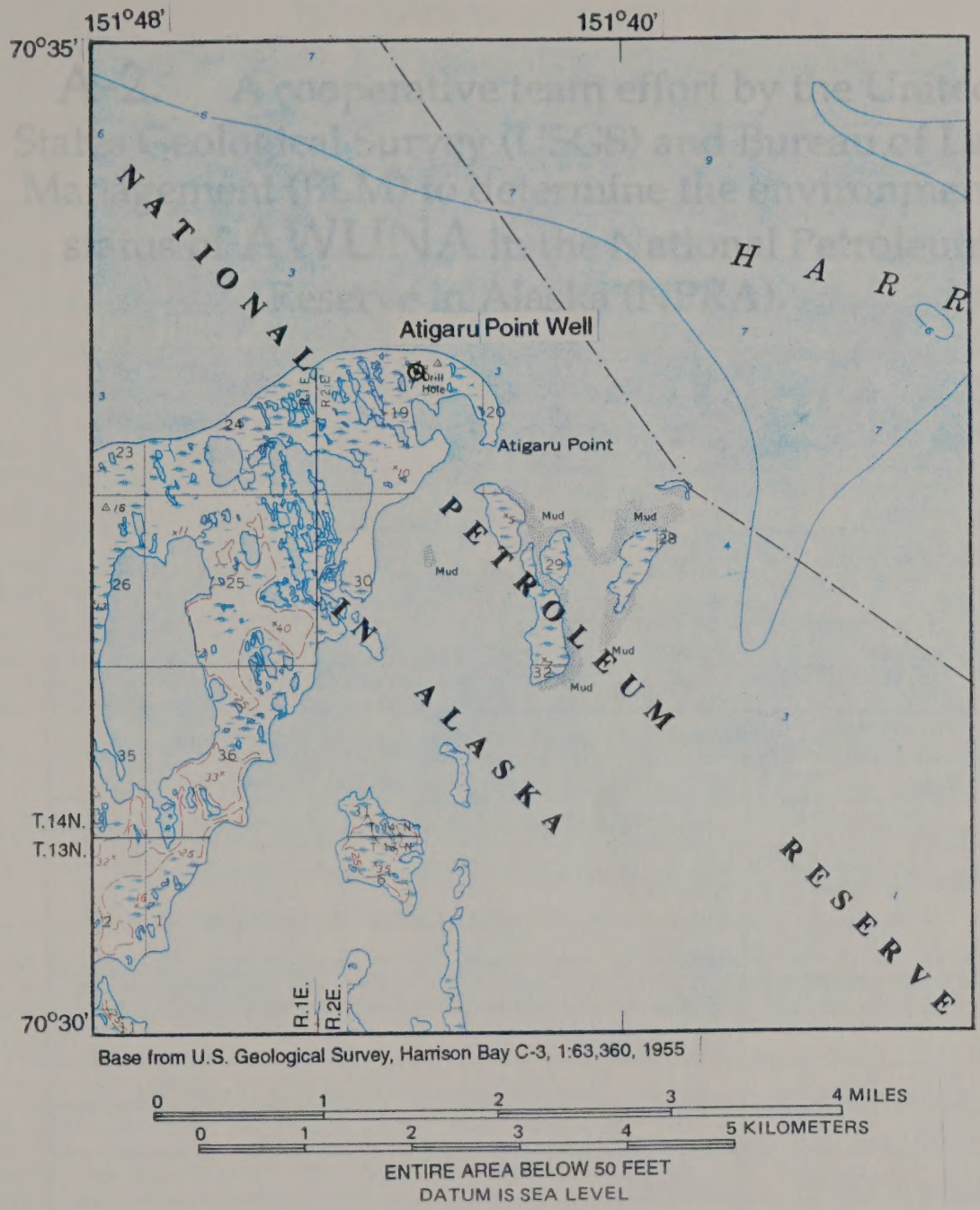


Location of Atigaru Point well.

A-2. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of AWUNA in the National Petroleum Reserve in Alaska (NPRA).

2. WELLSITE RISK DETERMINATION
AWUNA

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(Nuera), 1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1981,1982.
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	Edge of pad eroding into reserve pit
Subsidence	Occurring above ice wedges allowing inflow to and outflow from the reserve pit
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Revegetation generally effective on pad
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Covered by water up to nine feet deep in reserve pit
Other Solids	Pad eroding- exposing styrofoam and overlying plastic
Hydrocarbon Residue	TPH in a single soil sample elevated above background.
Contaminant Level	Barium, Fluoride and Chromium, elevated above MCL at single sites in 1989 survey-Barium and Chromium are below 1992 MCLs
Contaminant Migration	TPH in soil and Barium(1989 data) in water elevated up to 50 feet downgradient
Contaminant Persistence	Associated with sediments. Site more than 11 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible: Very remote site.

Awuna

Location and Drilling Characteristics

Latitude: 69°09'11.58" *Longitude*: 158°01'21.27"

Location: T. 3 S., R. 25 W., Sec. 30 SE 1/4, Umiat Meridian

Depth: 11,200 ft *Drilled*: 3/1/80 - 5/7/80 and 12/5/80 - 4/20/81

Description

Awuna Test Well No. 1 (plate 2A) is located about 150 mi south-southwest of Barrow. The well was drilled during two winter seasons. No drilling occurred during summer of 1980 to avoid disturbing caribou during the calving season in the Utukok Special Area. During the summer shutdown period, the northern part of the drilling pad eroded into the reserve pit. When drilling resumed in the winter, the eroded material was removed from the reserve pit and replaced on the pad.

The wellsite was reclaimed in 1981 and applications of seed and fertilizer were applied in 1981 and 1982. Water-quality samples were collected by the Nuera Reclamation Company in July 1984. The site was visited in 1989 but not in 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/13/84	8.0-12.5 °C	8.1-8.3	700-1,800 µS/cm	Nuera Reclamation Company (1986, p. 12-13)

Drilling Pad: A thin pad with styrofoam insulation with a plastic cover was constructed at the wellsite. The drilling pad and berms were constructed of material excavated from the reserve pit.

Reserve and Flare Pits: The reserve pit is open, not backfilled. Breaches allow water to flow through the pit. The flare pit is also open and not backfilled. The upper 2,000 ft of the 13-3/8-inch well casing was filled with JP5 fuel injected into the well during the summer shutdown season to keep the wellbore open. When drilling resumed, the JP5 fuel was burned in the flare pit. The berm between the reserve and flare pits has subsided and allows water to flow freely between the pits.

Summary of Reconnaissance Visit

Soil material from the pad near the wellhead and reserve pit is eroding into the reserve pit. As the materials erode, styrofoam from the pad is exposed, breaks off, and is being dispersed by wind and water as far as 5 mi from the site. Small pieces of styrofoam also broke up during construction and were dispersed by high winds. Revegetation generally is effective except in those parts of the pad underlain by styrofoam insulation.

Water draining from upland areas has formed extensive ponds along the entire western edge of the pad. As these ponds overflow, water flows both to the east across the pad and along the northern edge of the pad. This

movement of water across the pad has caused substantial erosion of materials that are subsequently deposited in the reserve pit. Water drains into the reserve pit from the adjacent terrain through a breach in the berm on the northern side and exits the pit through a breach on the eastern side. A smaller amount of water flows out of the flare pit through a breach on the eastern berm. Local snowmelt and rainfall also drain into the reserve pit from the pad. The elevation difference across the wellsite is about 11 ft.

The electromagnetic survey (plate 2B) done at the wellsite indicated no elevated earth conductivity measurements. The soil-gas survey (plate 2C) indicated one location having slightly elevated soil-gas concentrations. A sediment sample collected at this location (SL 9) contained no VOC's.

The water in the reserve pit was stratified. Dissolved-oxygen concentrations in water in the 9-foot deep pit ranged from 80 percent of saturation at the top to 3 percent at the bottom.

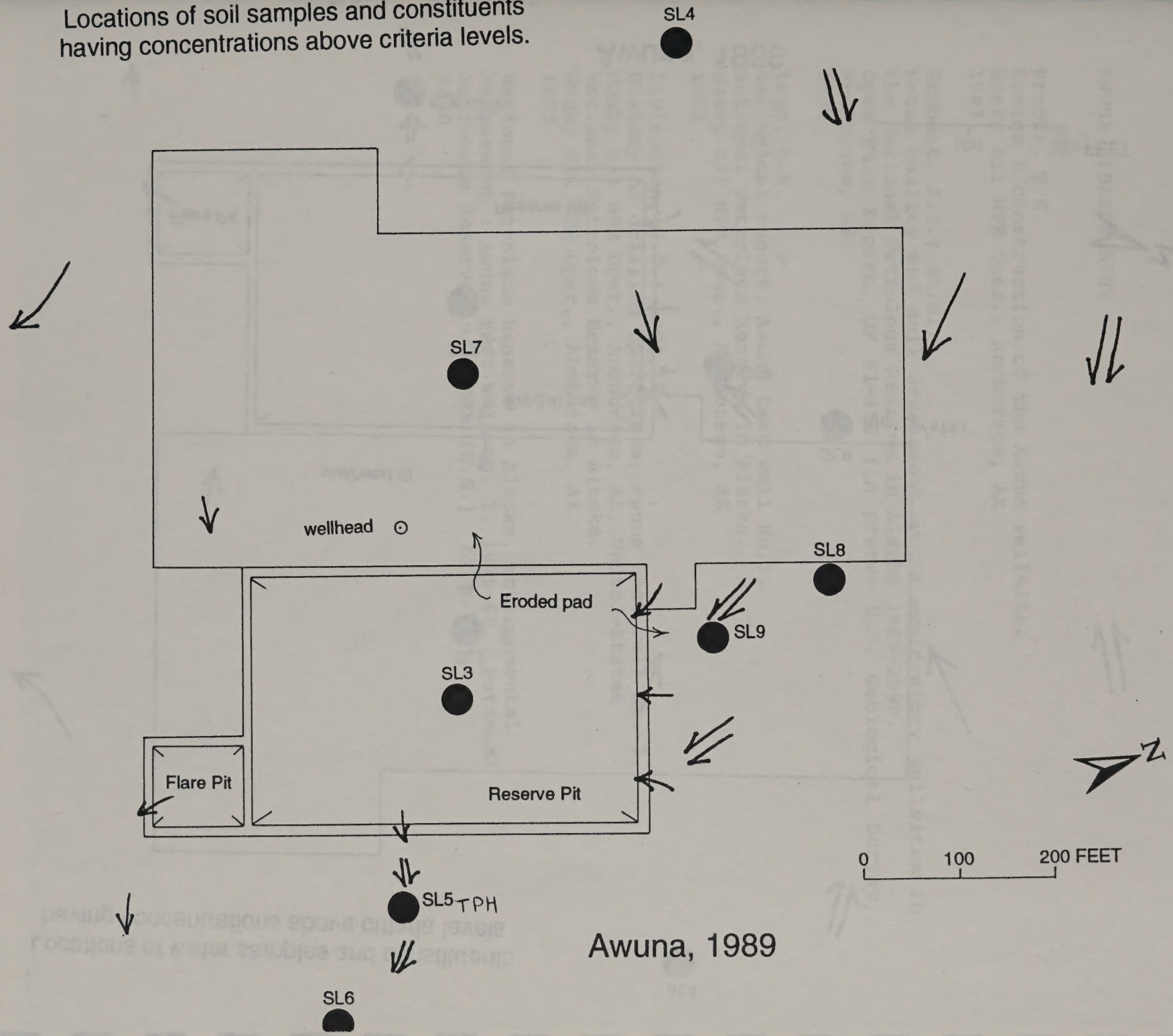
The specific conductance of water in ponds upgradient from the wellsite generally was less than 100 µS/cm. The specific conductance of water in the reserve pit was 298 µS/cm at 1 ft below the water surface. Downgradient from the reserve pit, water in a pond near SL 5 had a specific conductance of 340 µS/cm. Ponds A and K on the pad contained water having a specific conductance greater than 1,000 µS/cm. The pH of most water samples was slightly acidic to neutral.

The concentration of barium in water at SL 5 was 1.9 mg/L, which exceeds the MCL of 1 mg/L, but is less than the PMCL of 5 mg/L. Sediment samples collected from the reserve pit mud contained 1,200 mg/kg of barium and also contained substantial concentrations of chromium. A water sample collected from SL 5, 50 ft downgradient from the reserve pit, contained 36 µg/L of methylene chloride. This constituent is normally a laboratory contaminant, but none of the field or equipment blanks contained any methylene chloride. The source of methylene chloride is unknown. The soil at SL 5 had a TPH concentration of 280 mg/kg. Two other water samples had concentrations just above the MCLs for two constituents: fluoride was detected at a concentration of 4.1 mg/L (MCL is 4.0 mg/L) at SL 7 and chromium was detected at a concentration of 0.06 mg/L (MCL is 0.05 mg/L) at SL 2, 1 ft above the reserve pit bottom.

Brontosaurus

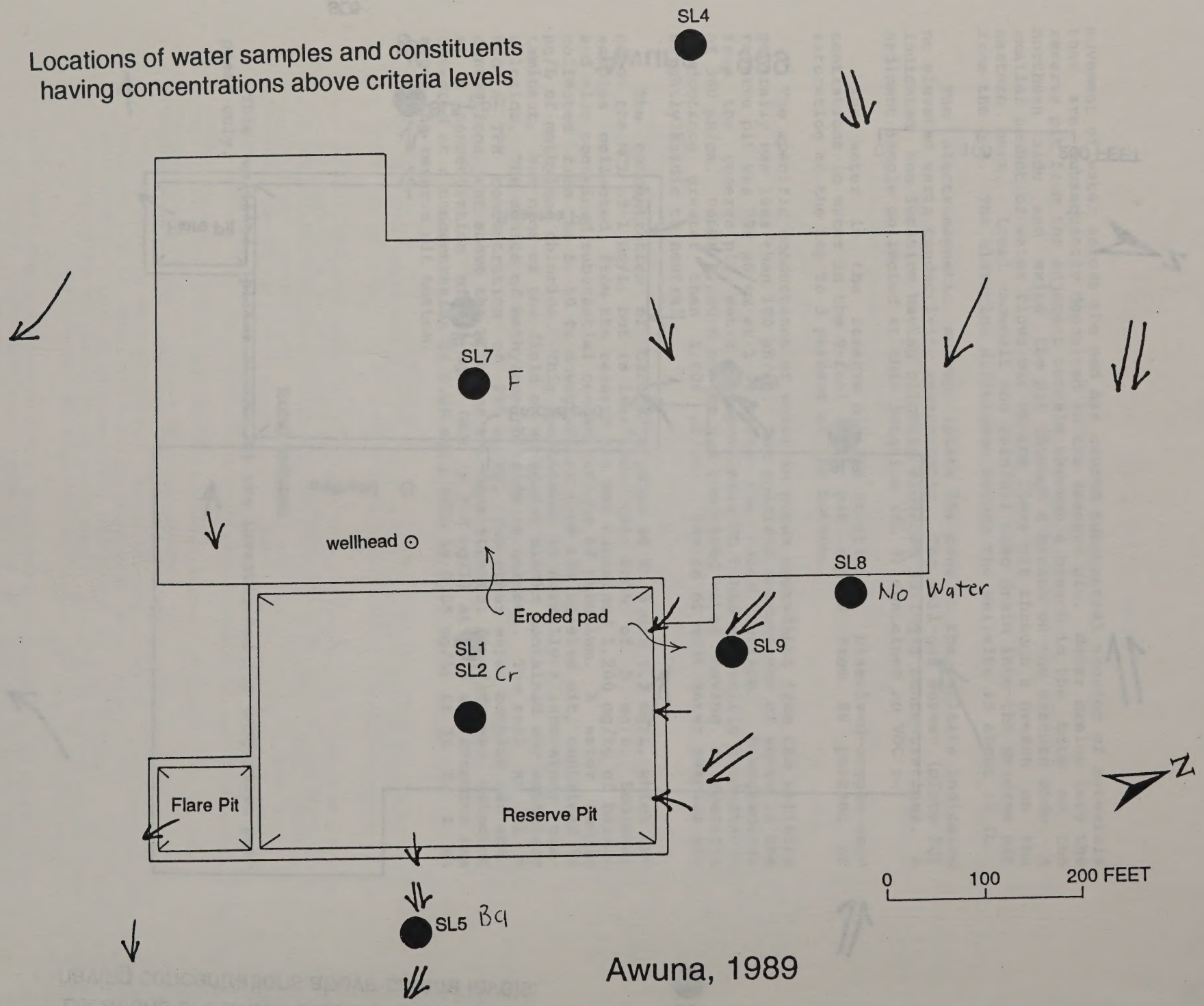
This wellsite (plates 3A and 3B) was investigated for comparison purposes only.

Locations of soil samples and constituents having concentrations above criteria levels.



Awuna, 1989

Locations of water samples and constituents having concentrations above criteria levels



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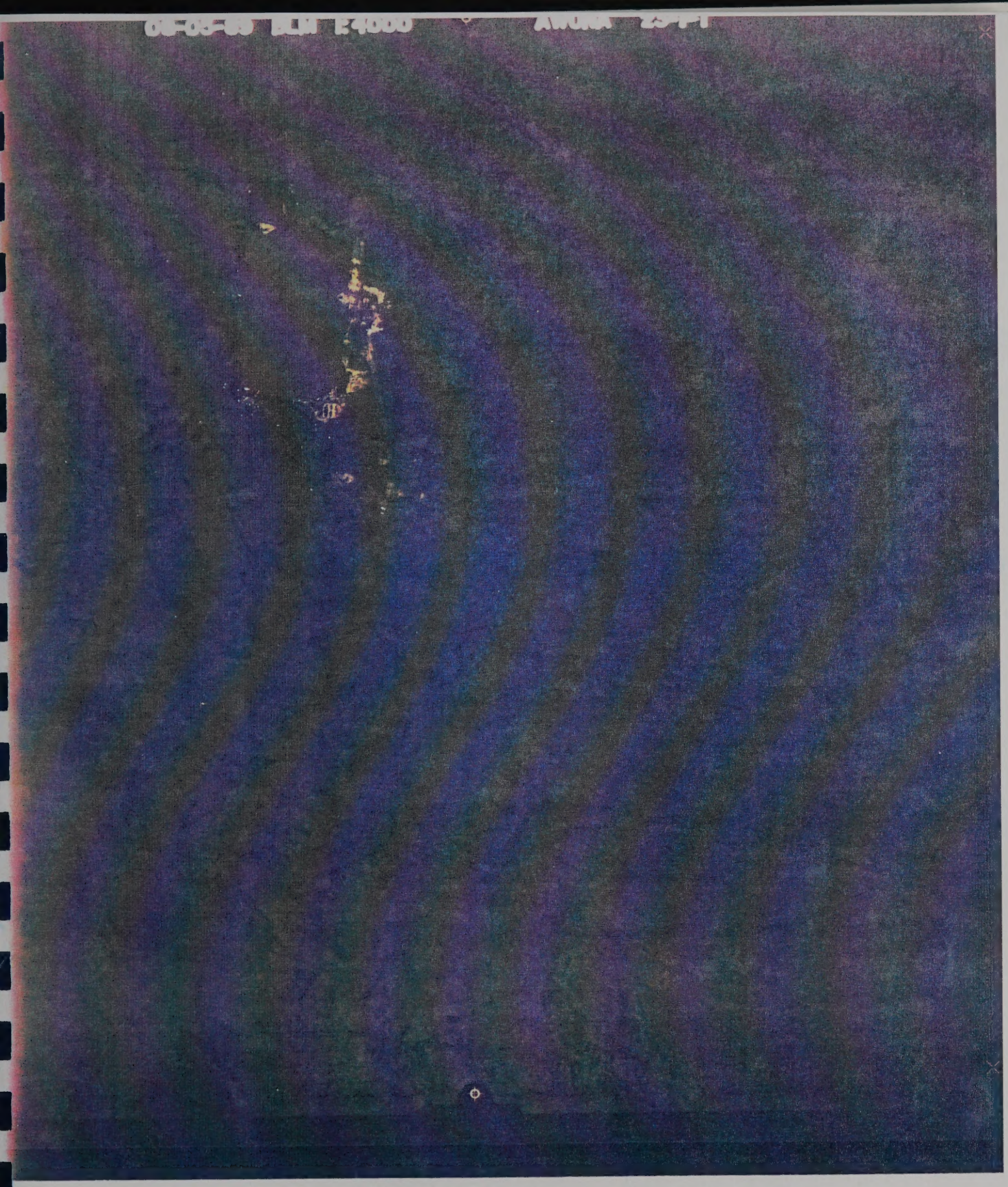
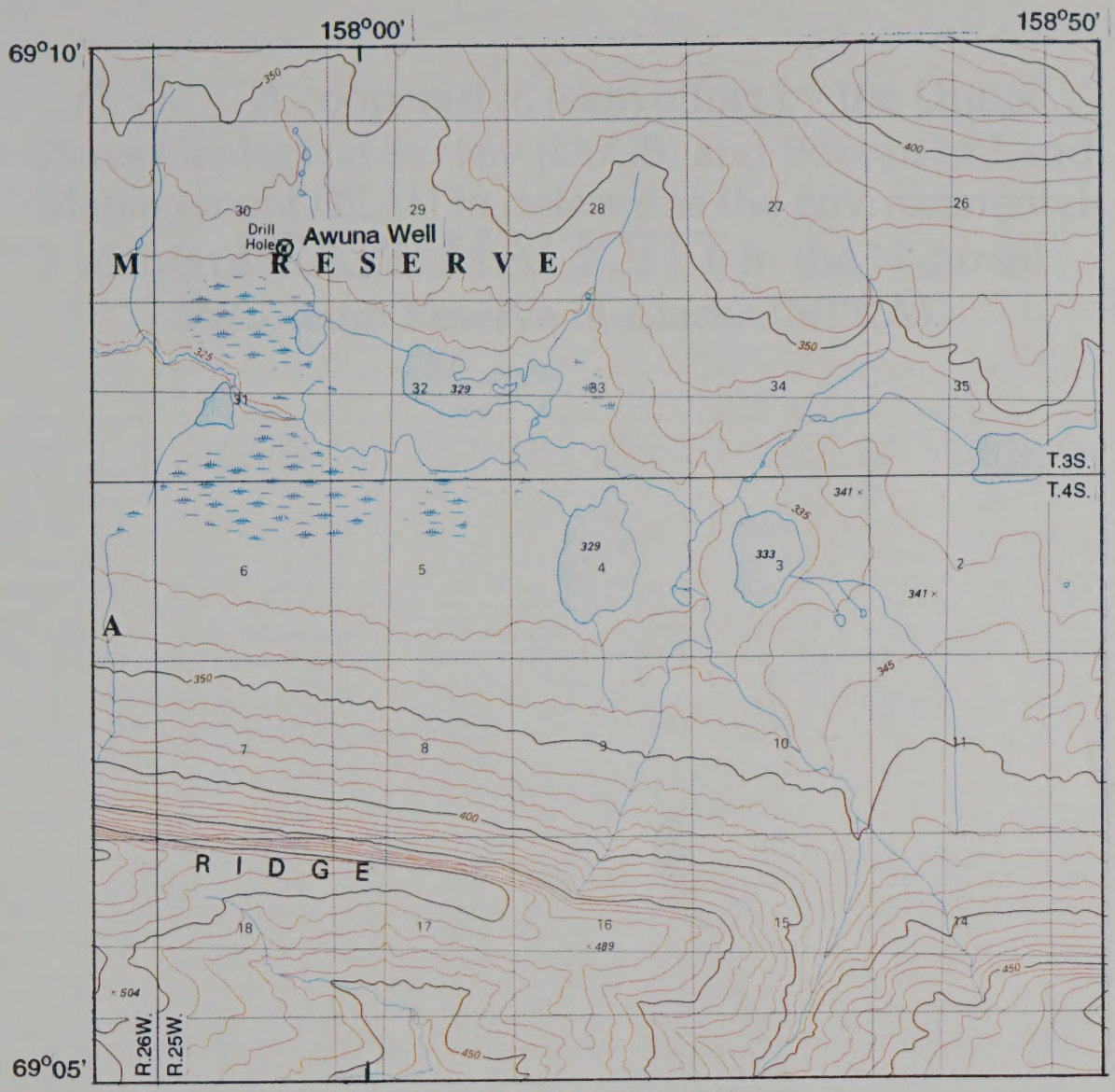
Localities of water samples and conditions at
the river concentrations above criteria levels





Base from U.S. Geological Survey, Lookout Ridge A-4, 1:63,360, 1984

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 10 METERS

DATUM IS SEA LEVEL

Location of Awuna well.

A-3. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of CAPE HALKETT in the National Petroleum Reserve in Alaska (NPRA).

3. WELLSITE RISK DETERMINATION
CAPE HALKETT

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1977,1978,1979,1980,1982
Leakage/Seepage	Site underwater
Erosion	None- Site underwater
Subsidence	Underwater
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Aquatic grass
Natural Processes	Natural processes have largely reclaimed site
Waste	
Drilling	No reserve pit dug: drilling waste mostly underwater
Other Solids	none observed
Hydrocarbon Residue	Elevated concentrations of TPH / not mobile
Contaminant Level	Elevated Barium, Chromium in 1989 survey- Barium and Chromium are below 1992 MCLs. BTEX above MCL
Contaminant Migration	Barium, Chromium (1989 data)and TPH 50 feet downgradient
Contaminant Persistence	TPH associated with sediments; Barium and Chromium diluted and nearly immobile. Site more than 17 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

Cape Halkett

Location and Drilling Characteristics

Latitude: 70°45′ *Longitude*: 152°26′

Location: T. 16 N., R. 2 W., Sec. 8, Umiat Meridian

Depth: 9,900 ft *Drilled*: 3/24/75 - 6/01/75

Description

Cape Halkett Test Well No. 1 (plate 4A) is near Cape Halkett at the northwestern end of Harrison Bay, about 104 mi southeast of Barrow. The area is swampy and inundated by water during parts of some years. The wellsite was seeded and fertilized in 1977, 1978, 1979, 1980, and 1982 with no success. No water-quality data were available prior to the 1989 sampling. The site was visited in 1989 but not 1990.

Drilling Pad: The drilling rig and heavy ancillary components were placed on pilings.

Reserve and Fuel Pits: No reserve pit was excavated. Gravel was hauled from Lonely to construct low (about 2 ft high) gravel berms. Drilling muds and cuttings were discharged directly onto tundra within these low berms. A low berm was constructed around the perimeter of the fuel-storage area.

Summary of Reconnaissance Visit

Virtually the entire wellsite was under water during the 1989 visit. Only a ridge of drilling mud and cuttings, extending down the middle of the wellsite, and other small patches of ground were protruding from the water. Pilings used to support the drilling rig were cut off below the water surface. The sampling routine used at the other sites was used at this site, but ground-water samples are essentially surface-water samples collected at the same location where a ground-water sample would have been collected. Because of standing water and limited access by foot, no soil-gas survey and only a limited electromagnetic (EM) survey was done. The EM survey indicated background earth conductivity measurements of 2 to 3 mS/m (plate 4B). Earth conductivities of 7 to 9 mS/m were detected along the ridge of drilling mud.

The pH of water over the wellsite ranged from 7 to 8.7, except at the wellhead where a water sample had a pH of 10.2. Specific conductance values of water ranged from 240 to 349 µS/cm, except for a water sample collected near the wellhead, which had a specific conductance of 1,320 µS/cm.

TPH concentrations were 1,000, 2,000, and 910 mg/kg in soil samples collected at SL 5, midpad, and SL 8, respectively. Oil and grease concentrations at the same sites also were elevated in soil samples. The water sample collected at SL 5 contained an oil and grease concentration of 9.9 mg/L. The concentrations of BTEX in soil at SL 8 was 2.4 mg/kg and exceeded the PMCL. Concentrations of barium (1.1 mg/L) and chromium (0.08 mg/L) in water at SL 5 exceeded the MCLs.

Drew Point

Location and Drilling Characteristics

Latitude: 70°52′47.14" *Longitude*: 153°53′59.93"

Location: T. 18 N., R. 8 W., Sec. 26 SE 1/4, Umiat Meridian

Depth: 7,946 ft *Drilled*: 1/13/78 - 3/13/78

Description

Drew Point Test Well No. 1 (plate 5A) is on the southeastern side of Smith Bay, about 70 mi southeast of Barrow in an area of little topographic relief. The ground is about 14 ft above sea level. No water-quality data were available prior to 1989. This site was visited in 1989 but not in 1990.

Drilling Pad: A thick drilling pad was used. Material for the pad was taken from a partially drained lake basin near the northern end of Imakruak Lake about 6 mi south of the wellsite. The pad was seeded and (or) fertilized in 1979, 1980, 1981 and 1982.

Reserve and Flare Pits: The reserve pit was backfilled. Backfill is now at about 60 percent of the reserve pit's storage capacity. Two large breaches on the south side of the berm allow water out of the pit. Berms around the flare pit are stable and in good condition. No drainage of water from the flare pit has been observed.

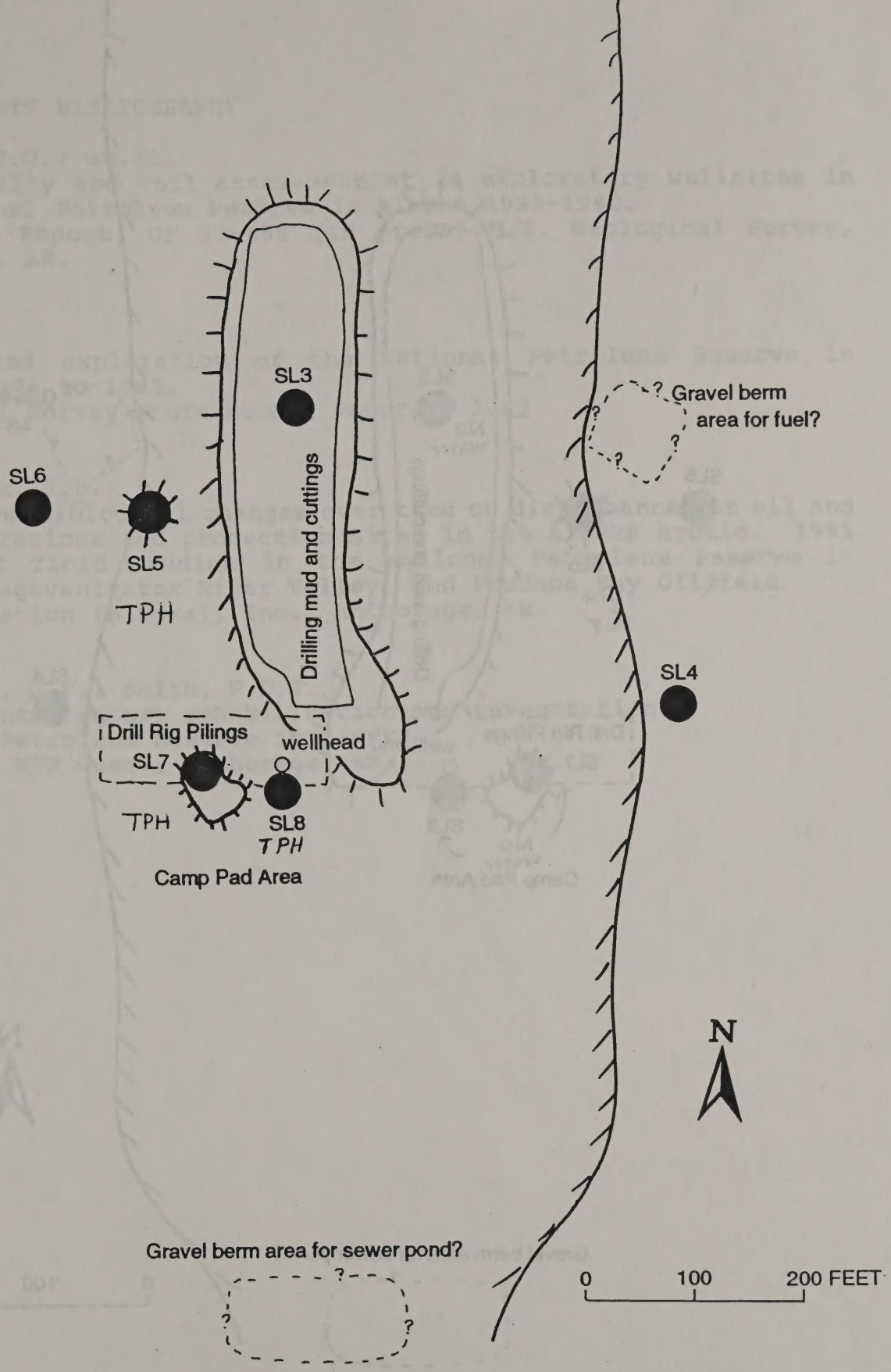
Summary of Reconnaissance Visit

Vegetation on reclaimed areas at this coastal wellsite is sparse except in microrelief features. The wellsite is flat, but terrain east of the wellsite is slightly higher, and most of the drainage is to the west. Two large breaches in the berm on the southern side allow water out of the pit. Water leaving the pit through these breaches flows westward along the outside of the berm.

The electromagnetic survey (plate 5B) and the specific conductances of water samples indicated slightly elevated measurements because of proximity of the wellsite to the ocean. Specific conductance measurements of water were generally above 1,000 µS/cm, but were 346 and 467 µS/cm in water in Ponds B and C upgradient from the wellsite. Within the site, the highest earth conductivities measured were near the flare pit; a sample at this location (SL 9) was collected. No significant concentrations that exceeded the MCLs or PMCLs were detected in the sample.

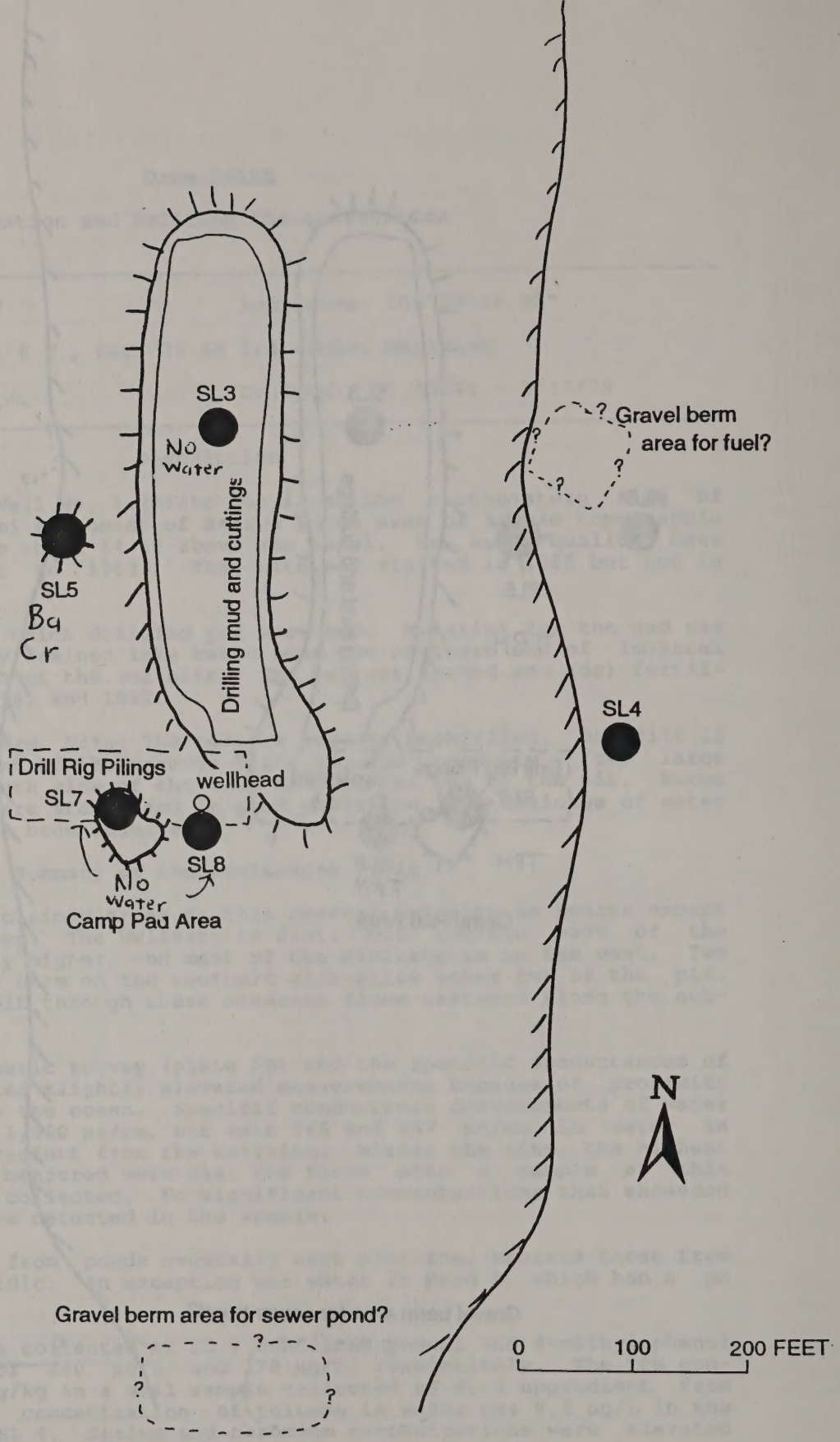
Water samples from ponds generally were alkaline, whereas those from ground water were acidic. An exception was water in Pond B, which had a pH of 6.8.

The water sample collected at SL 7 contained phenol and 4-methyl phenol at concentrations of 280 µg/L and 170 µg/L, respectively. The TPH concentration was 120 mg/kg in a soil sample collected at SL 4 upgradient from the wellsite. The concentration of toluene in water was 8.5 µg/L in the sample collected at SL 4. Barium and chromium concentrations were elevated in sediment samples from SL 9.



Cape Halkett, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



Cape Halkett, 1989

Locations of water samples and constituents having concentrations above criteria levels

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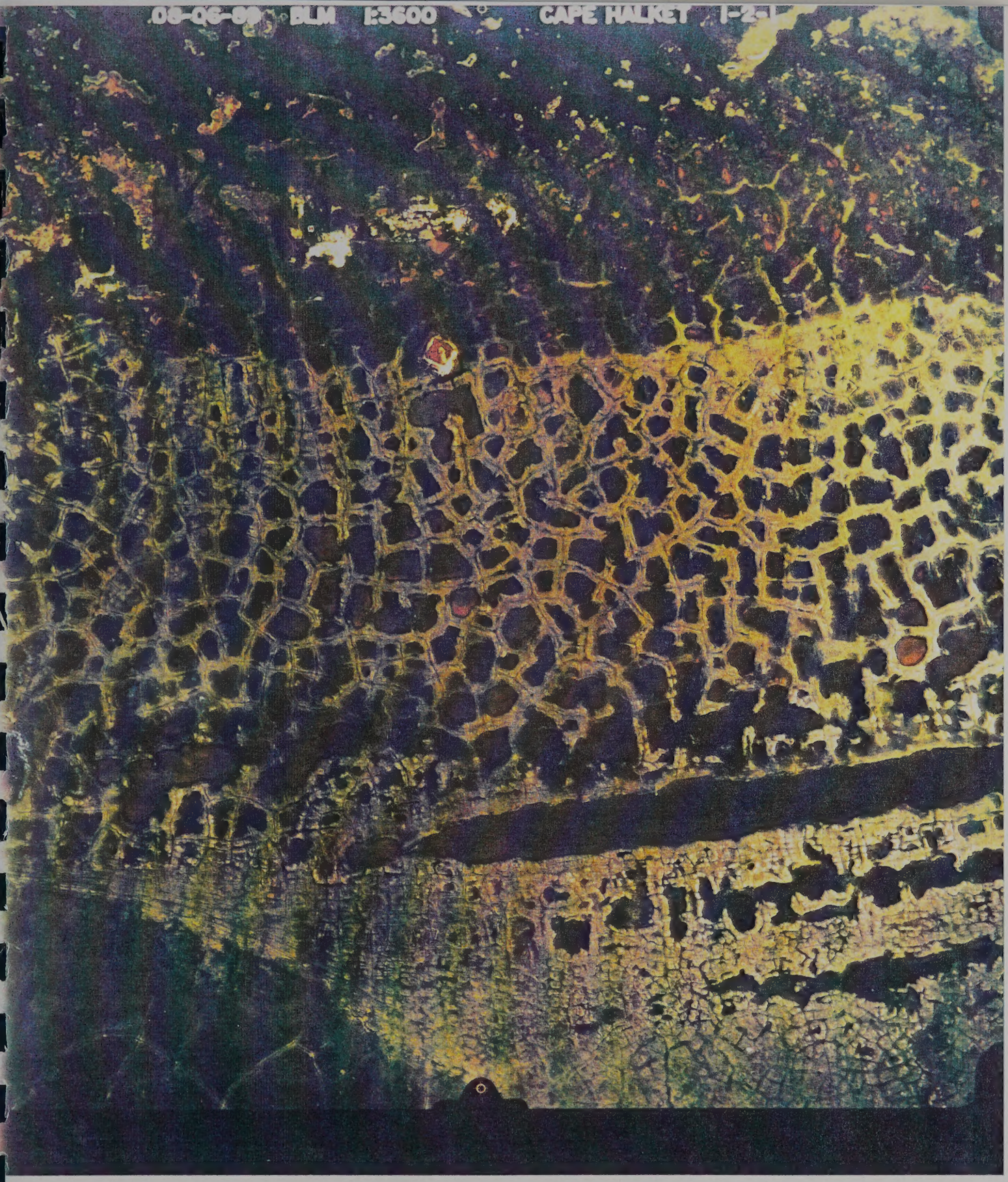
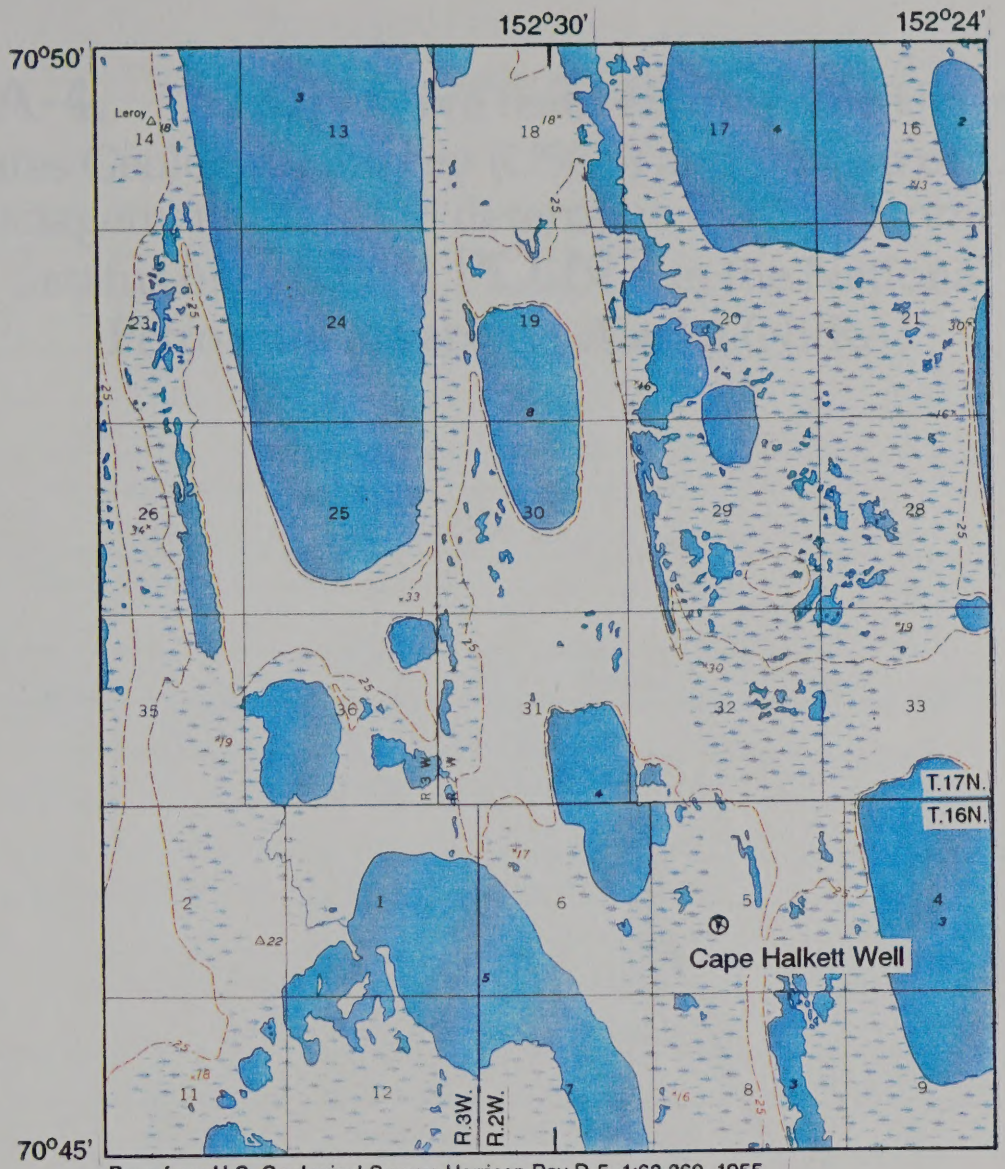
Cape Halkett, 1989

Locations of water samples and constituents having concentrations above criteria levels


08-06-88 BLM E3600 CAPE HALKET



Base from U.S. Geological Survey, Harrison Bay D-5, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

ENTIRE AREA BELOW 50 FEET
DATUM IS SEA LEVEL

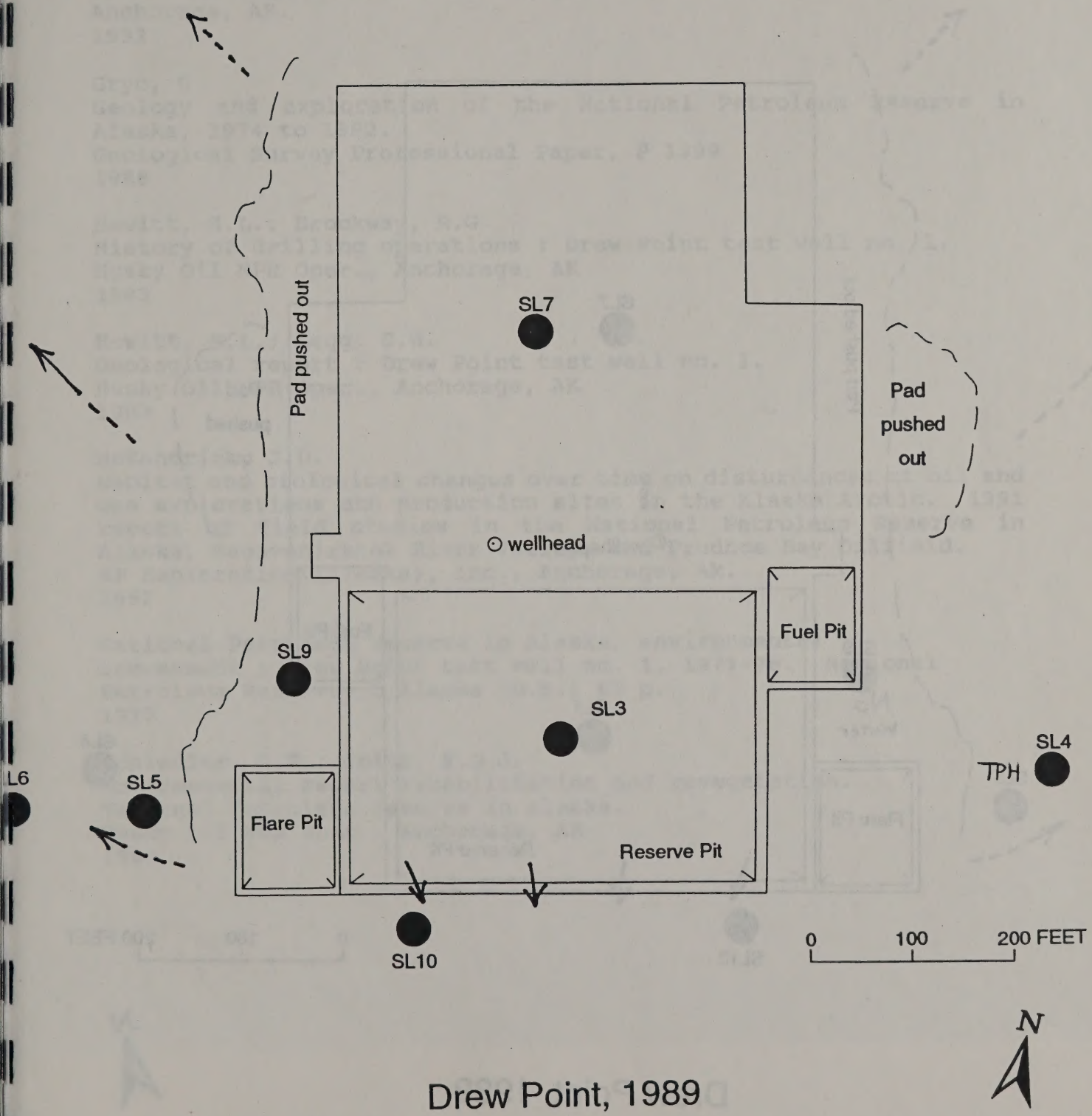
Location of Cape Halkett well.

A-4. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of DREW POINT in the National Petroleum Reserve in Alaska (NPRA).

4. WELLSITE RISK DETERMINATION

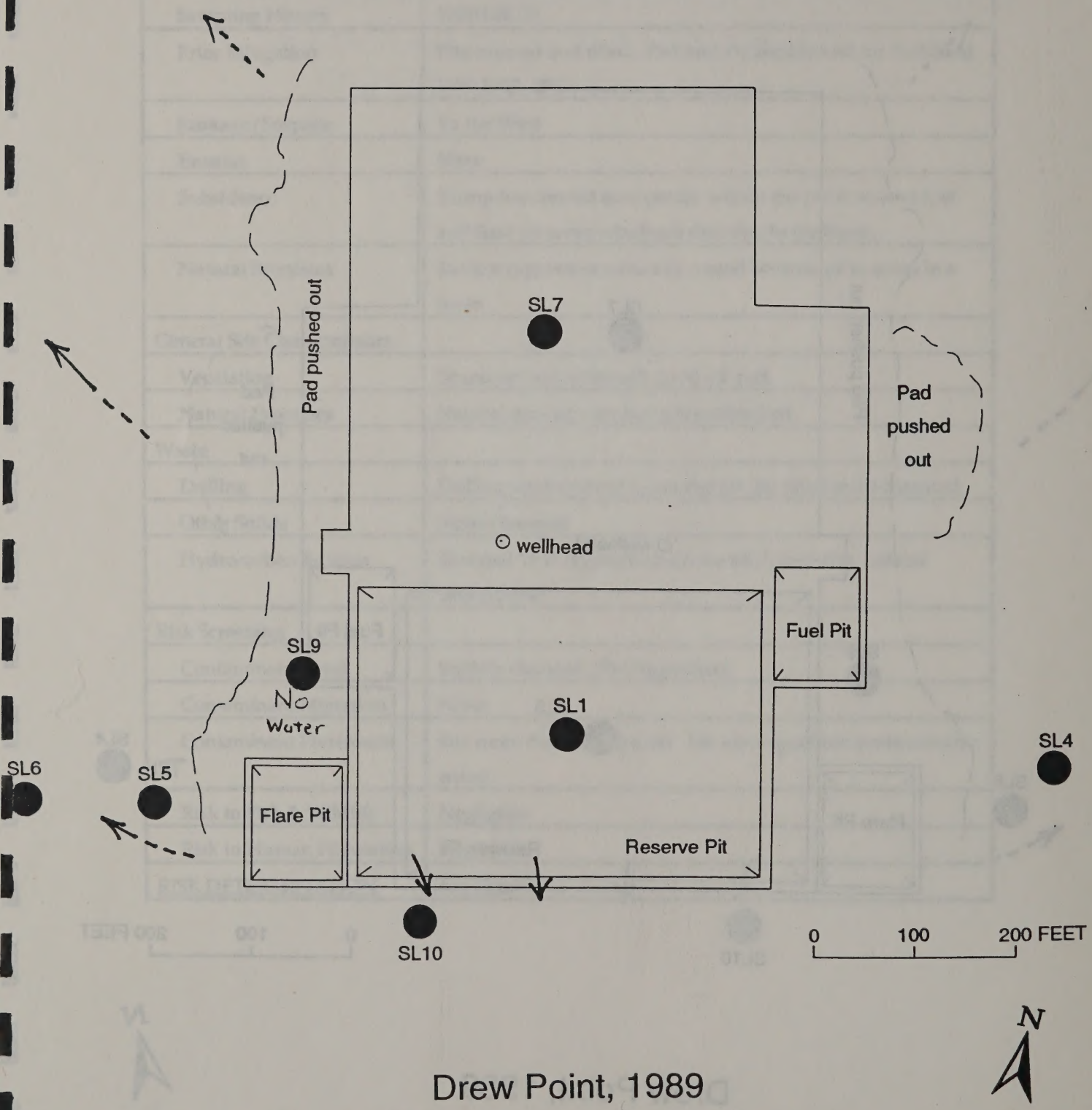
DREW POINT

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Pits covered and filled. Pad and Pit Seeded and/or Fertilized 1979,1980, 1982
Leakage/Seepage	To the West
Erosion	None
Subsidence	Slump has created new ponds within the prior reserve fuel and flare pit areas which are draining to the South
Natural Processes	Surface expression naturally muted because of location in a basin
General Site Characteristics	
Vegetation	Sparse on pad, generally good off pad
Natural Processes	Natural drainage are being reestablished
Waste	
Drilling	Drilling waste buried in reserve pit, pit filled and contoured
Other Solids	None observed
Hydrocarbon Residue	Elevated TPH upgradient- above MCL probably natural background
Risk Screening	
Contaminant Level	Slightly elevated TPH upgradient
Contaminant Migration	None
Contaminant Persistence	Site more than 14 years old. No downgradient contamination noted
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible



Drew Point, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



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Locations of water samples and constituents having concentrations above criteria levels

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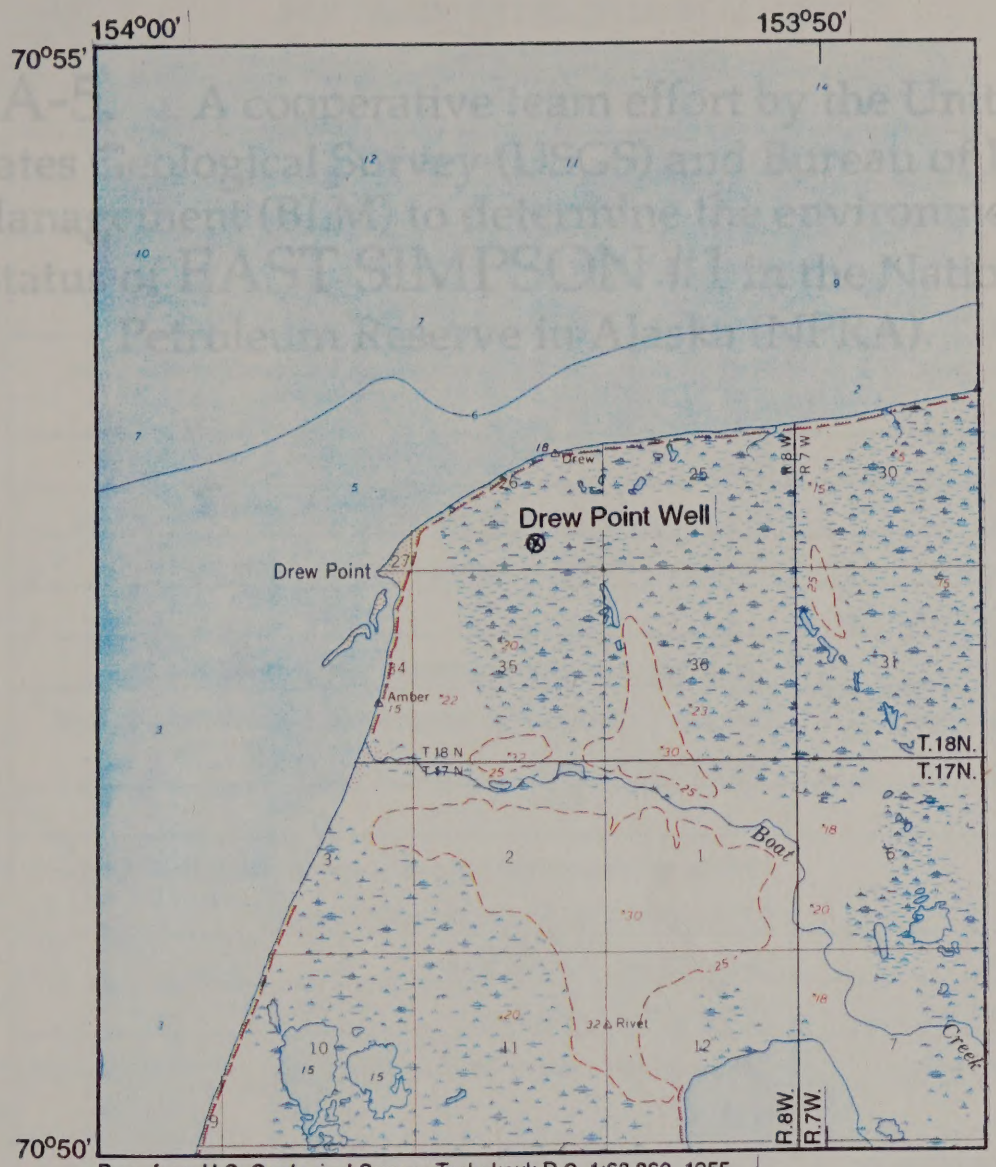
08-06-89 BLM 1:3000 DREW PT. 6-2-2



Location of Drew Point well.

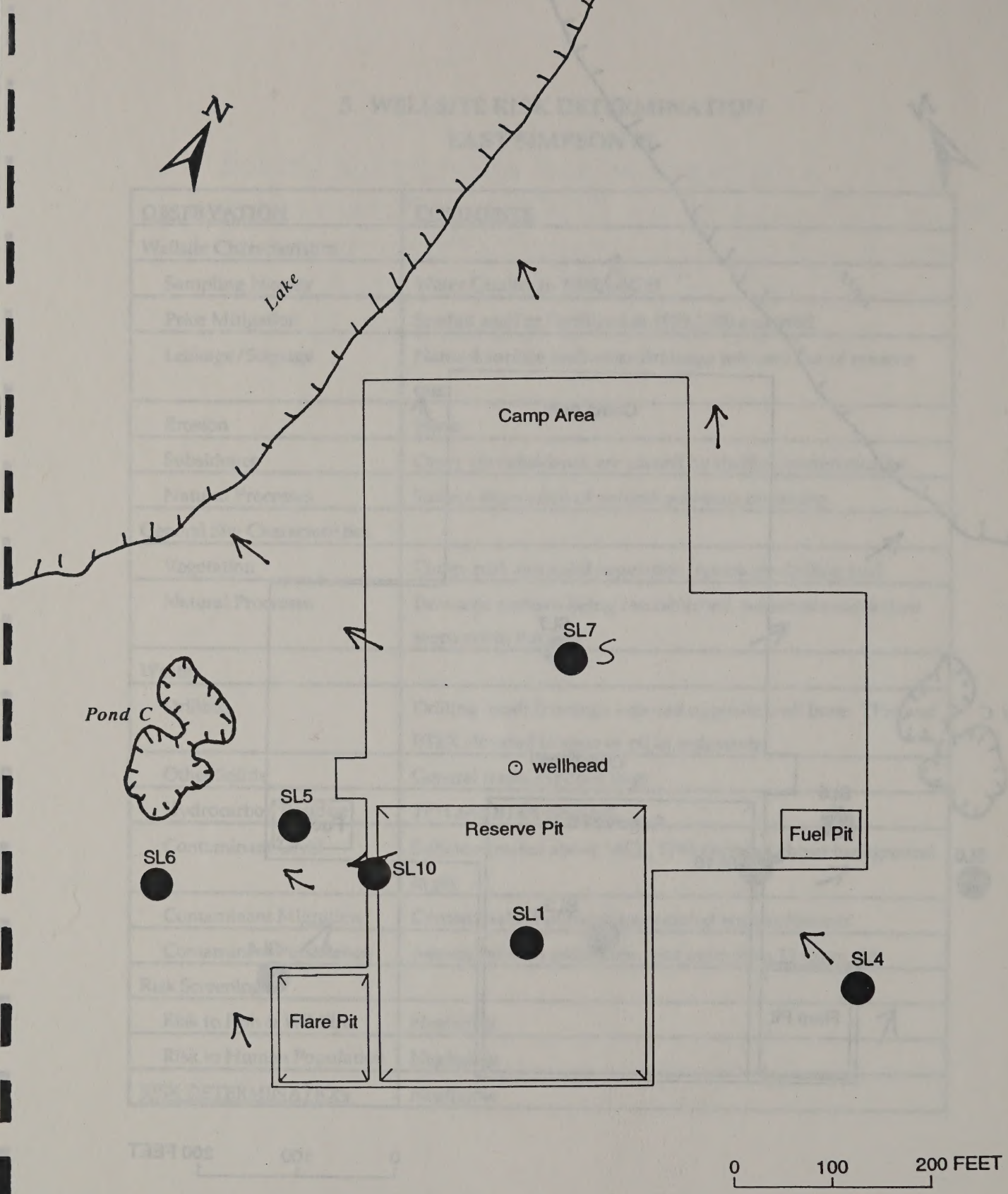
A-5. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of EAST SIMPSON #1 in the National Petroleum Reserve in Alaska (NPRA).

5. WELLSITE RISK DETERMINATION
EAST SIMPSON #1

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	Water Quality in 1989(USGS)
Prior Mitigation	Seeded and/or Fertilized in 1979,1980 and 1982
Leakage/Seepage	Natural surface meltwater drainage into and out of reserve pits
Erosion	None
Subsidence	Open pit subsidence are caused by melting underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Camp pad has good vegetation, sparse on drilling pad
Natural Processes	Drainage patterns being reestablished, numerous natural oil seeps are in the area
Waste	
Drilling	Drilling muds/cuttings exposed opposite well bore: TPH and BTEX elevated in reserve pit in sediments
Other Solids	General trash, exposed liner
Hydrocarbon Residue	TPH and BTEX elevated
Contaminant Level	Sulfate elevated above MCL, TPH elevated above background in pit
Contaminant Migration	Contaminants not mobile associated with sediments
Contaminant Persistence	Associated with sediments. Site more than 13 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

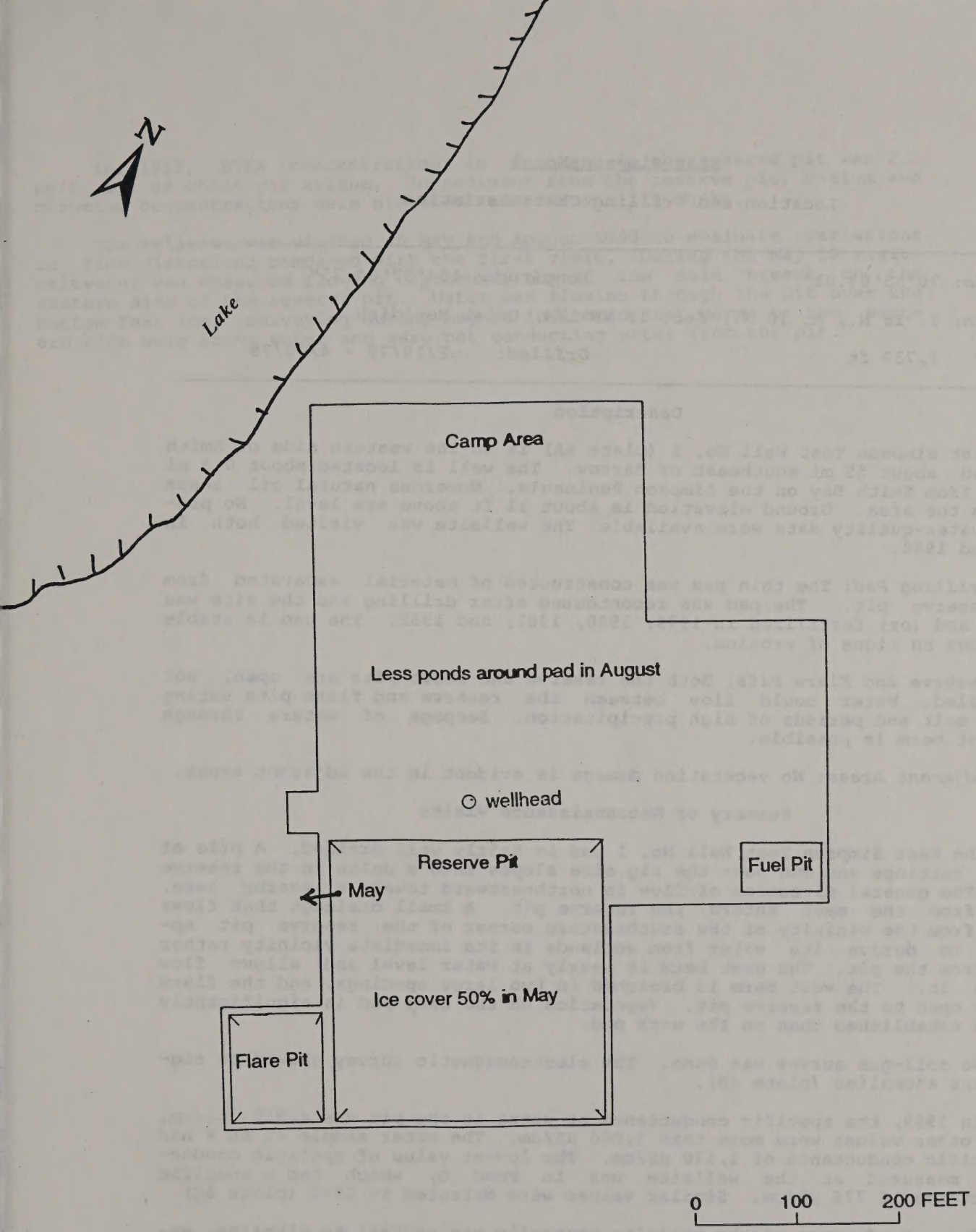
East Simpson No.1, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



East Simpson No.1, 1989

Locations of water samples and constituents having concentrations above criteria levels



East Simpson No. 1

May 30, 1990 & August 4, 1990

East Simpson No. 1

Location and Drilling Characteristics

Latitude: 70°55'04.01" *Longitude*: 154°37'04.75"

Location: T. 18 N., R. 10 W., Sec. 18 NW 1/4, Umiat Meridian

Depth: 7,739 ft *Drilled*: 2/19/79 - 4/10/79

Description

East Simpson Test Well No. 1 (plate 6A) is on the western side of Smith Bay and about 55 mi southeast of Barrow. The well is located about 0.3 mi inland from Smith Bay on the Simpson Peninsula. Numerous natural oil seeps are in the area. Ground elevation is about 11 ft above sea level. No previous water-quality data were available. The wellsite was visited both in 1989 and 1990.

Drilling Pad: The thin pad was constructed of material excavated from the reserve pit. The pad was recontoured after drilling and the site was seeded and (or) fertilized in 1979, 1980, 1981, and 1982. The pad is stable and shows no signs of erosion.

Reserve and Flare Pits: Both the reserve and flare pits are open, not backfilled. Water could flow between the reserve and flare pits during spring melt and periods of high precipitation. Seepage of waters through the west berm is possible.

Adjacent Areas: No vegetation damage is evident in the adjacent areas.

Summary of Reconnaissance Visits

The East Simpson Test Well No. 1 pad is fairly well drained. A pile of drill cuttings and mud near the rig site slopes into a delta in the reserve pit. The general direction of flow is northwestward toward a nearby lake. Flow from the east enters the reserve pit. A small drainage that flows south from the vicinity of the southeastern corner of the reserve pit appears to derive its water from wetlands in its immediate vicinity rather than from the pit. The east berm is nearly at water level and allows flow across it. The west berm is breached in two large openings, and the flare pit is open to the reserve pit. Vegetation on the camp pad is significantly better established than on the work pad.

No soil-gas survey was done. The electromagnetic survey showed no significant anomalies (plate 6B).

In 1989, the specific conductance of water in the pit was 4,310 µS/cm. Most other values were more than 1,000 µS/cm. The water sample at SL 4 had a specific conductance of 1,170 µS/cm. The lowest value of specific conductance measured at the wellsite was in Pond O, which had a specific conductance of 776 µS/cm. Similar values were detected in 1990 (plate 6C).

The pH of water at the wellsite generally was neutral to alkaline, except at scattered sites in 1989. A water sample collected at SL 10 was an exception, with the lowest pH, 4.9. The pH of water in the reserve pit was 9.0.

In 1989, BTEX concentration in sediment in the reserve pit was 2.2 µg/L, all of which was xylene. In sediment from the reserve pit, barium and chromium concentrations were elevated and TPH was 120 mg/kg.

The wellsite was visited in May and August 1990 to evaluate variations in flow directions compared with the first visit. During the May 30 visit, meltwater was observed flowing vigorously out of the main breach on the western side of the reserve pit. Water was flowing through the pit over the bottom-fast ice. Surveying during August indicated that berms on the western side were above water and were not conducting water from the pit.

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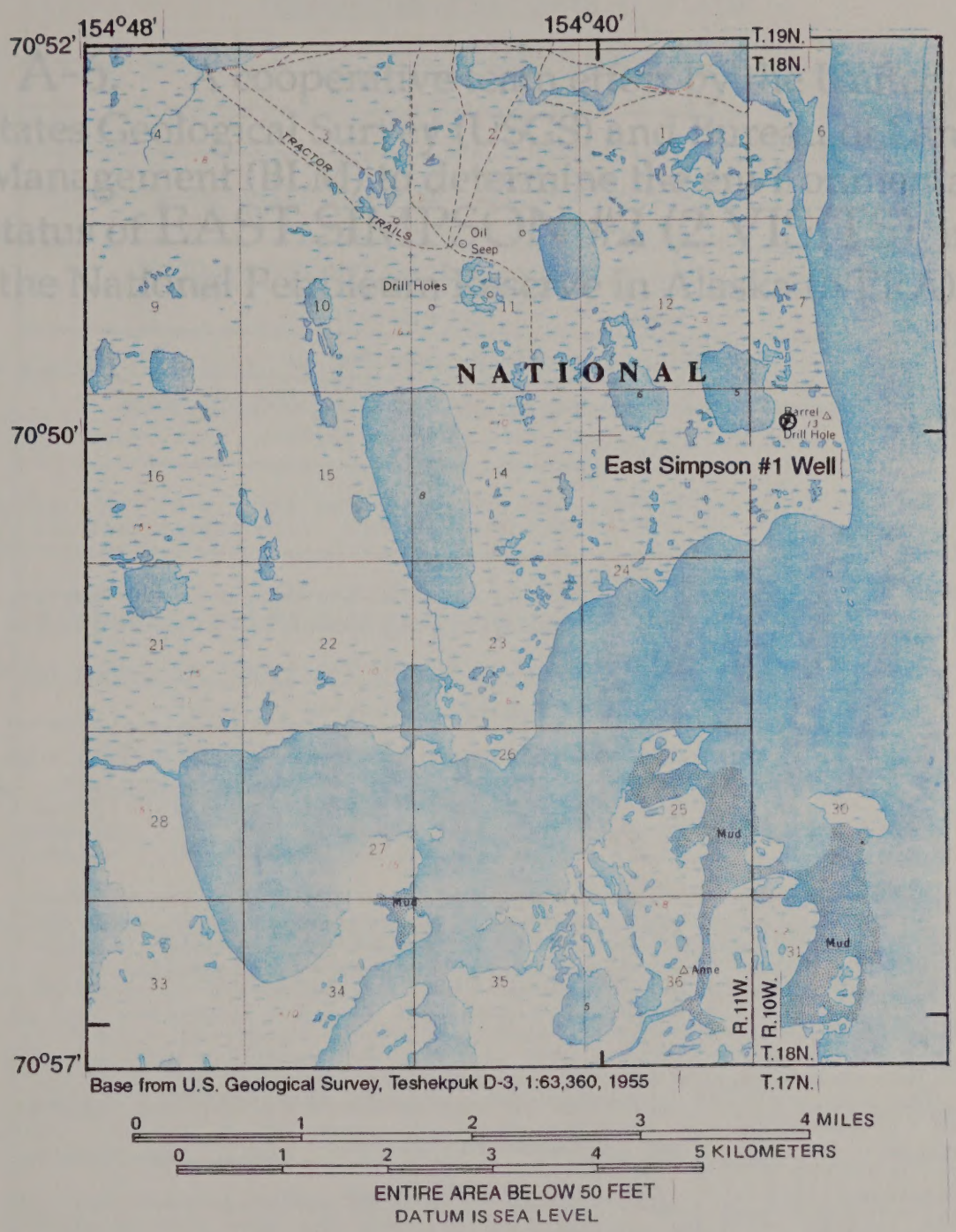
08-06-89 BLM 1:3600
E SIMPSON NO. 1 16-2-2



Location of East Simpson No. 1 well.

A-6. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of EAST SIMPSON #2 (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

6. WELLSITE RISK DETERMINATION
EAST SIMPSON #2

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989,1990 (USGS)
Prior Mitigation	Seeded and/or Fertilized 1979,1980,1981,1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Pit and berms have subsided
Natural Processes	Surface expression of natural polygons have returned
General Site Characteristics	
Vegetation	Moderate
Natural Processes	Drainage patterns being reestablished. Oil seeps in area
Waste	
Drilling	Pits covered by up to 9 feet of water. TPH and BTEX elevated above background in reserve pit. TPH elevated in flare pit(1989).
Other Solids	None observed
Hydrocarbon Residue	TPH and BTEX elevated on pad and adjacent to pit
Contaminant Level	Elevated TPH and BTEX above background
Contaminant Migration	None
Contaminant Persistence	Associated with sediments. Site more than 12 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

East Simpson No. 2

Location and Drilling Characteristics

Latitude: 70°58′42.51" *Longitude*: 154°40′25.74"

Location: T. 19 N., R. 11 W., Sec. 23 SE 1/4, Umiat Meridian

Depth: 7,505 ft *Drilled*: 1/29/80 - 3/15/80

Description

East Simpson Test Well No. 2 (plate 7A) is located about 52 mi southeast of Barrow on the Simpson Peninsula, about 1.5 mi inland (west) from Smith Bay. The ground is about 21 ft above sea level. No previous water-quality data were available. The site was visited in both 1989 and 1990.

Drilling Pad: The thin pad and berms were constructed using material excavated from the reserve pit. The site was seeded and (or) fertilized in 1980, 1981, and 1982.

Reserve and Flare Pits: Berms around both the reserve and flare pits have all but disappeared by thermokarst settling and by wave erosion.

Adjacent Areas: No vegetation damage is evident in the adjacent areas.

Summary of Reconnaissance Visits

Drainage through this wet coastal site is toward the north and northwest. The pad is moderately well revegetated by moss, but grasses are not established. Some areas near the wellhead are unvegetated. The berms have subsided and are breached on all sides, allowing water to flow through the reserve pit.

The 1989 electromagnetic survey indicated background readings of 5 to 6 mS/m on all sides of the wellsite except the north (plate 7B). An anomaly of 8 to 9 mS/m extends on the north side to the limit of the survey, about 200 ft downgradient from the reserve pit. The specific conductance of water in the reserve pit is 647 µS/cm, which is higher than specific conductances of water in the background ponds of 213, 186, and 208 µS/cm. High specific-conductance water, as shown by 1,730 µS/cm in Pond Y near the wellhead, exists where flushing is not active. In May 1990, when ice covered the pit, specific conductance of water under the ice was 2,720 µS/cm; water on top of the ice had specific conductances ranging from 43 to 75 µS/cm (plate 7C). By midsummer, water in the reserve pit had returned to a value similar to its 1989 specific conductance.

A soil-gas survey with the organic vapor analyzer in 1989 indicated elevated concentrations near the rig site (plate 7B). A soil sample was collected near the rig site at SL 9; the TPH concentration was 1,900 mg/kg and the BTEX concentration was 2.5 mg/kg. BTEX also exceeded the PMCL at SL 10 with a concentration of 1.1 mg/kg in 1989.

East Simpson No. 2 was one of the sites chosen for analysis of background concentrations of TPH (fig. 6). Following additional soil-gas surveying in 1990 (plate 7E), the TPH concentration at SL 9 was confirmed as being high--1,260 mg/kg in July. SL 9A, 15 ft north of SL 9, had TPH concentrations of 1,600 mg/kg in May and 4,690 mg/kg in July. The flare pit had a TPH concentration of 1,420 mg/kg and BTEX of 9.0 mg/kg. An elevated soil-gas concentration was also identified on the western side of the reserve pit. Soil sample N150 W350 near the flare pit had a TPH

concentration of 90 mg/kg. In addition, TPH concentrations were 266 mg/kg in reserve pit sediment, and 81 mg/kg at N465 W360, near SL 10.

Most of the water samples had pH greater than 7.0. The ponds in upgradient areas, however, were slightly acidic.

East Simpson No. 2 was selected as one of two sites for detailed sampling to determine whether the reconnaissance sampling of 1989 had been adequate to identify chemical contaminants. A grid was established at the site oriented to the configuration of the reserve pit. Samples were collected at 50-foot intervals close to the reserve pit and at 100-foot intervals farther away from it (plate 7D).

In general, the grid sampling did not identify any sites of contamination that had not been identified in 1989. There was, however, one major exception to this conclusion. Chromium in water was not identified as a problem in 1989, but in 1990, the MCL of 0.05 mg/L was exceeded in the following water samples:

Sample point	Concentration of chromium (mg/L)
N200 W350	0.081
N200 W500	.074
N415 W 15	.067
N700 W500	.067
SL 6	.067
N200 W400	.060
N600 W450	.052

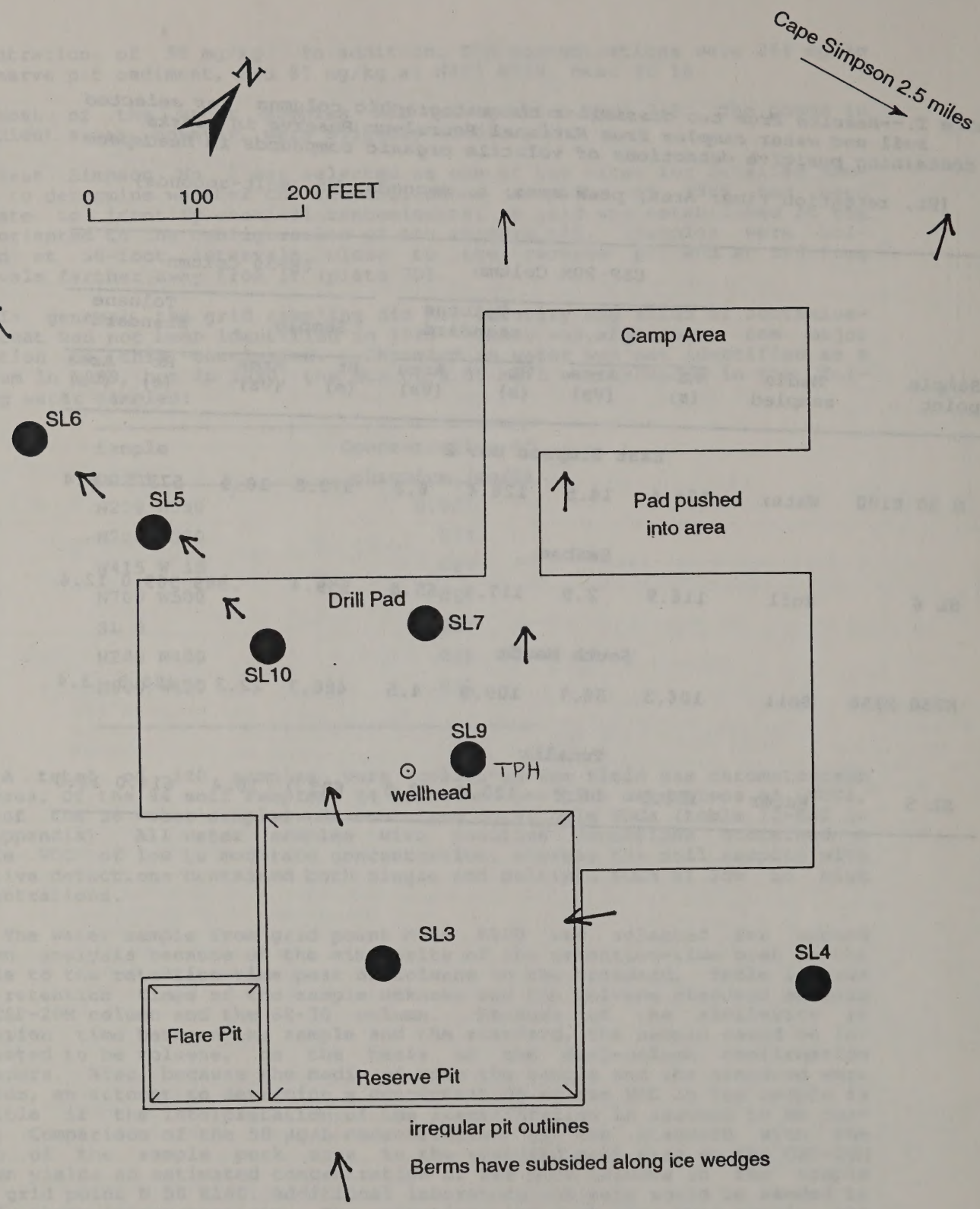
A total of 140 samples were collected for field gas chromatograph analyses. Of the 84 soil samples, 24 contained positive detections of VOCs, and of the 56 water samples, 24 contained detectable VOCs (table 12-ES2 in the appendix). All water samples with positive detections contained a single VOC of low to moderate concentration, whereas the soil samples with positive detections contained both single and multiple VOCs of low to high concentrations.

The water sample from grid point N 50 E100 was selected for second column analysis because of the similarity of the retention-time peak in the sample to the retention-time peak of toluene in the standard. Table I shows the retention times of the sample unknown and the toluene standard on both the CSP-20M column and the SE-30 column. Because of the similarity in retention time between the sample and the standard, the sample could be interpreted to be toluene, on the basis of the dual-column confirmation procedure. Also, because the media of both the sample and the standard were aqueous, an attempt to determine a concentration of the VOC in the sample is possible if the interpretation of the identification is assumed to be correct. Comparison of the 50 µg/L concentration of the standard with the ratio of the sample peak area to the standard peak area on the CSP-20M column yields an estimated concentration of 106 µg/L toluene in the sample from grid point N 50 E100. Additional laboratory analysis would be needed to verify these interpretations. The retention-time peak from this sample was similar to other single VOC peaks detected at East Simpson No. 2 and at other wellsites, although not all single VOC peaks were analyzed on both chromatographic columns.

Table I.--Results from two dissimilar chromatographic columns for selected soil and water samples from National Petroleum Reserve in Alaska containing positive detections of volatile organic compounds in headspace

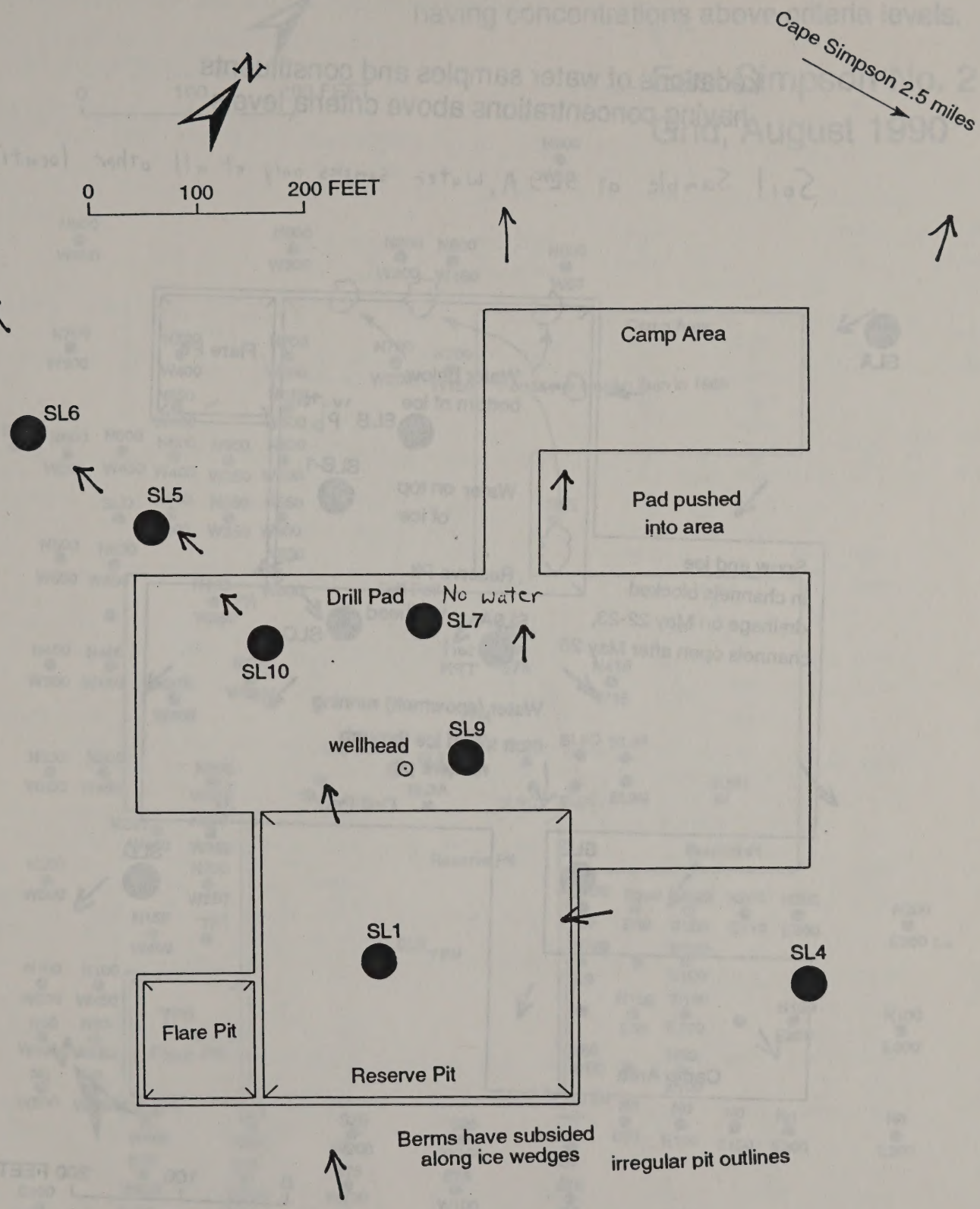
[Rt, retention time; Area, peak area; s, seconds; Vs, volt-seconds]

		CSP-20M Column				SE-30 Column			
		Sample		Toluene standard		Sample		Toluene standard	
Sample point	Media sampled	Rt (s)	Area (Vs)	Rt (s)	Area (Vs)	Rt (s)	Area (Vs)	Rt (s)	Area (Vs)
East Simpson No. 2									
N 50 E100	Water	124.4	14.5	124.4	6.8	573.8	10.9	573.8	6.4
Seabee									
SL 6	Soil	116.9	2.9	117.4	65.8	559.4	.999	569.0	12.4
South Meade									
N250 E150	Soil	106.3	38.7	109.9	4.5	480.3	22.3	480.3	3.4
Tunalik									
SL 5	Water	122.1	56.2	120.4	63.8	603.7	10.4	614.0	11.0



East Simpson No. 2, 1989

Locations of soil samples and constituents having concentrations above criteria levels.

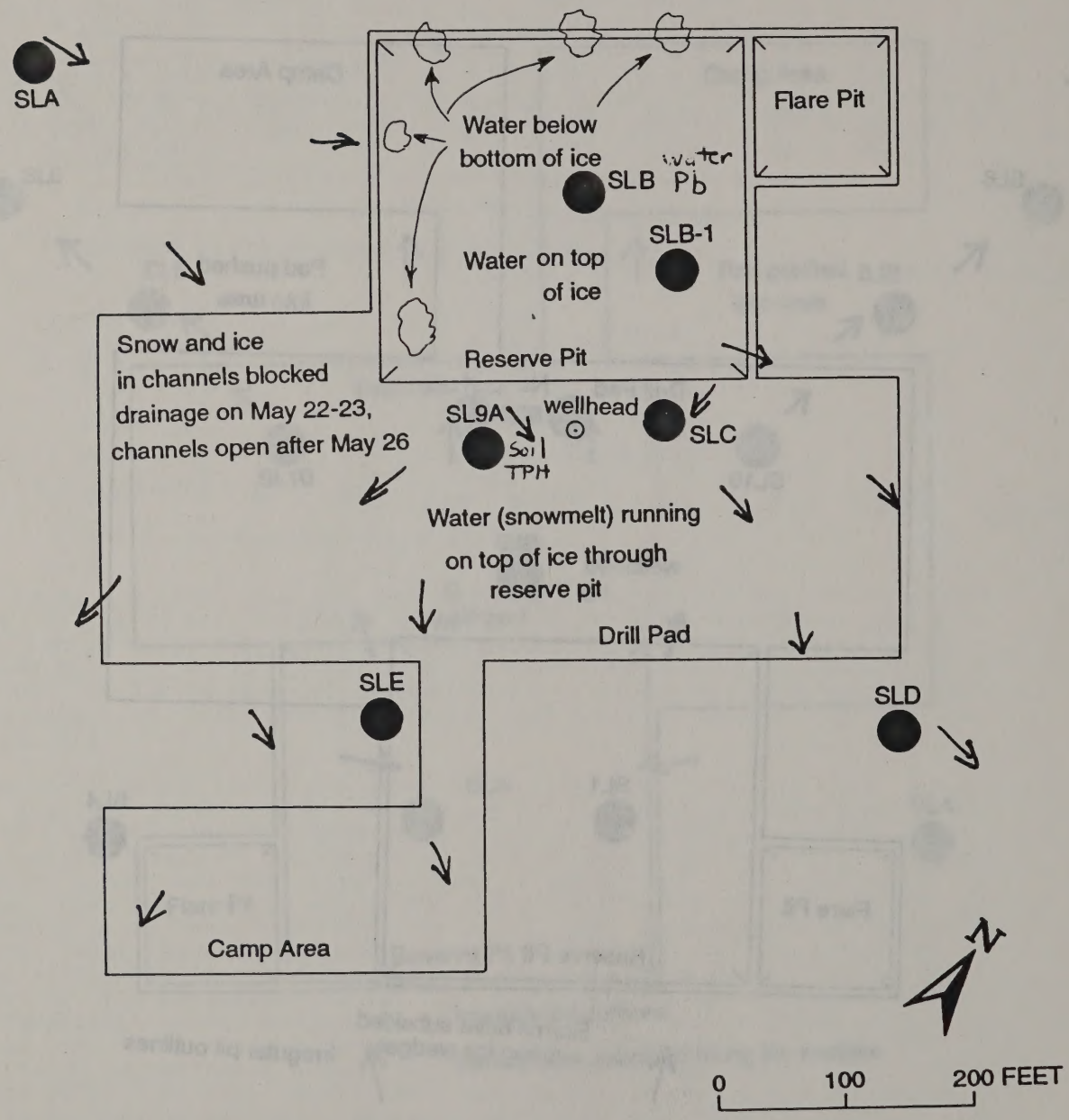


East Simpson No. 2, 1989

Locations of water samples and constituents
having concentrations above criteria levels

Locations of water samples and constituents
having concentrations above criteria levels

Soil Sample at SL9A, water samples only at all other locations.



East Simpson No. 2

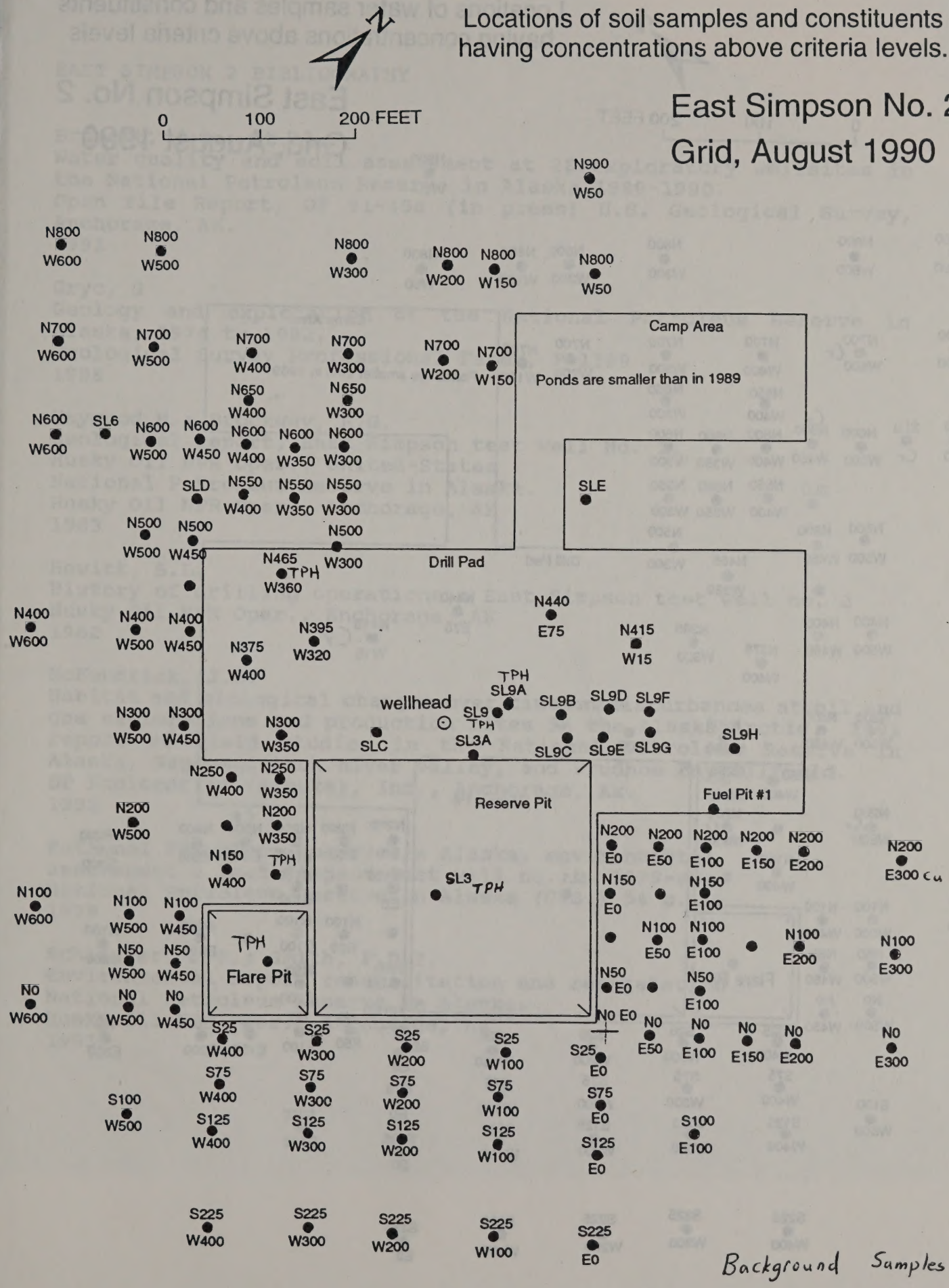
May 22-23, 1990

May 26, 1990

May 30, 1990

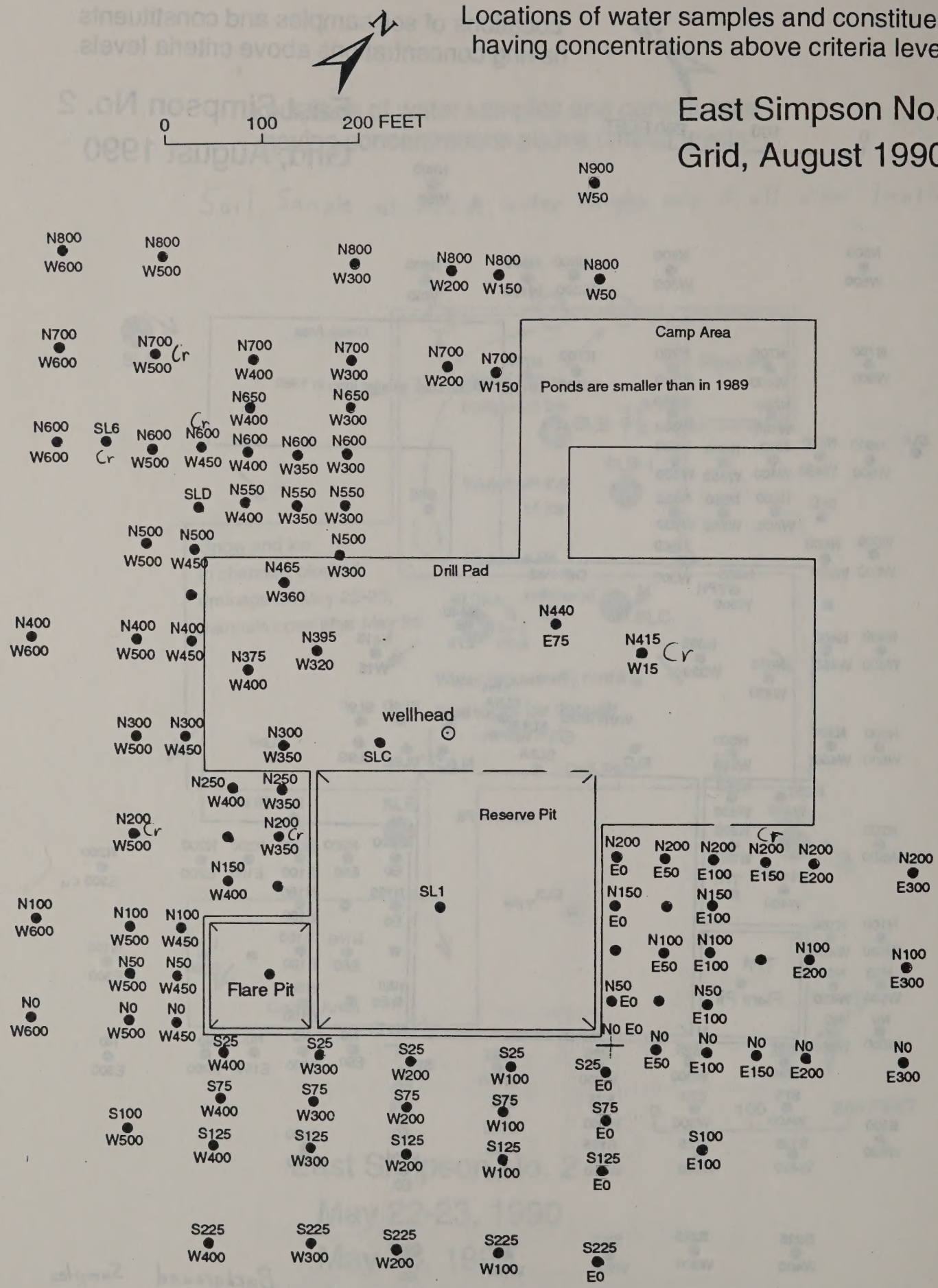
Locations of soil samples and constituents having concentrations above criteria levels.

East Simpson No. 2 Grid, August 1990



Locations of water samples and constituents having concentrations above criteria levels

East Simpson No. 2 Grid, August 1990



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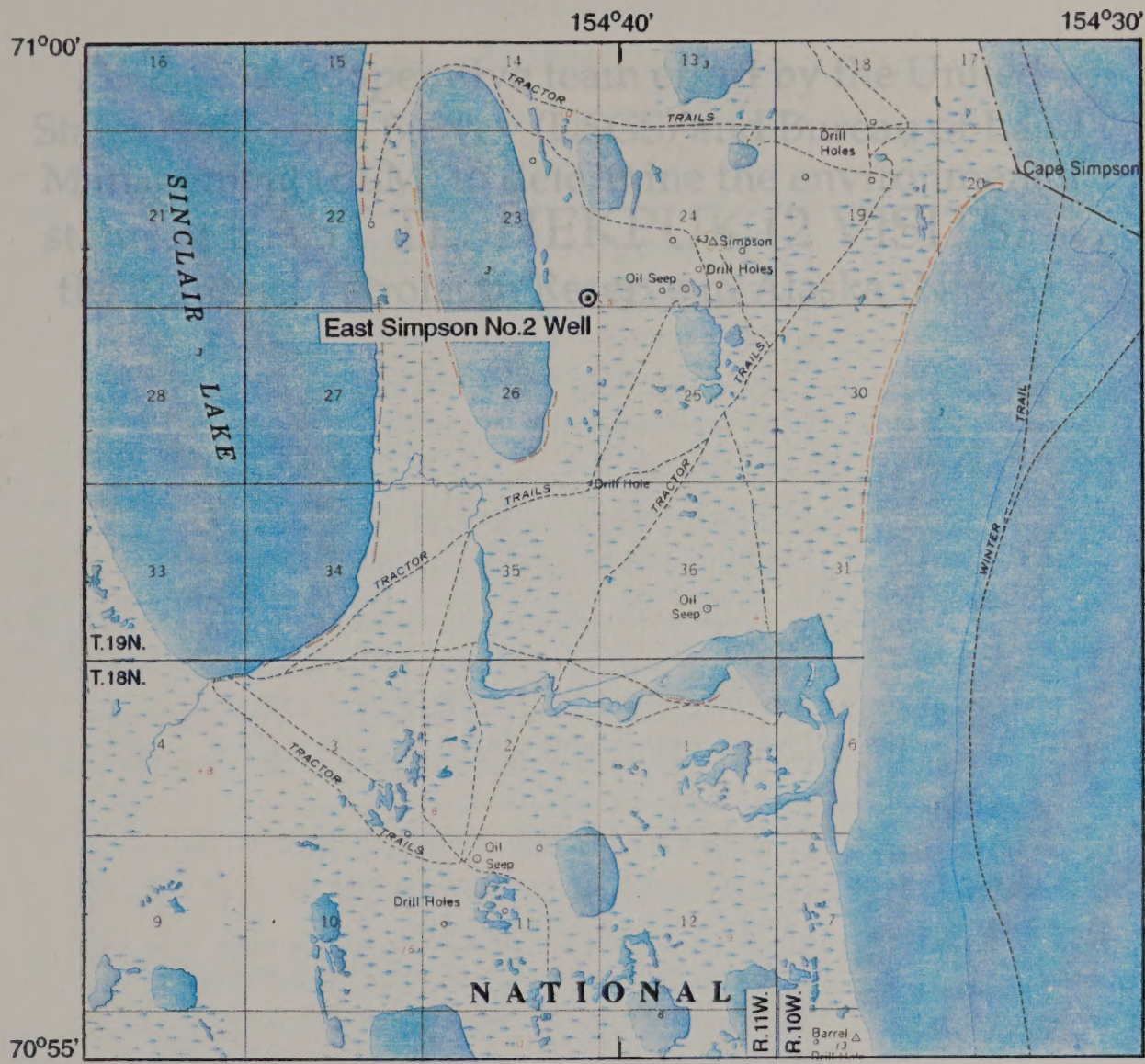
1983



Base from U.S. Geological Survey, Teshekpuk D-3, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of East Simpson No. 2 well.

A-7. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of EAST TESHEKPUK (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

7. WELLSITE RISK DETERMINATION
EAST TESHEKPUK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA)1983,1989,1990(USGS)
Prior Mitigation	Pits backfilled with pad material and recontoured. Seeded and/or Fertilized 1978
Leakage/Seepage	Residual pond leaking into the lake through polygon channel. Natural ice polygons being reestablished
Erosion	Slight erosion from filled flare and reserve pit material onto the lake shore
Subsidence	Minimal subsidence in one portion of the reserve pit
Natural Processes	Surface expression of natural ice polygons returning in pad area
General Site Characteristics	
Vegetation	Sparse, inhibited by salts leaching at the surface
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Covered by up to 6 feet of sand from original pad
Other Solids	Some metal debris in flare pit area on lakeshore
Hydrocarbon Residue	TPH in sediment is highly elevated
Contaminant Level	Chromium elevated above MCL in the lake in 1989 survey-Chromium is below 1992 MCLs. TPH in 1989 was substantially above background-however a reduction noted in 1990
Contaminant Migration	Constituents from the drilling muds are evident in the near shore sediments of Teshekpuk Lake
Contaminant Persistence	TPH associated with sediments have moved offsite in eroding material and are being disbursed and degraded. Site is more than 16 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

East Teshekpuk

Location and Drilling Characteristics

Latitude: 70°34′11.661" *Longitude*: 152°56′36.905"

Location: T. 14 N., R. 4 W., Sec. 16 NW 1/4 Umiat Meridian

Depth: 10,664 ft *Drilled*: 3/12/76 - 5/11/76

Description

East Teshekpuk Test Well No. 1 (plate 8A) is located on an east-west peninsula projecting into Teshekpuk Lake at the eastern margin of the 315 square-mile lake. The wellsite is located about 100 mi southeast of Barrow and 25 mi south-southeast of Lonely. Drilling was done in one winter season. In April 1976, the drilling muds and cuttings in the reserve pit reached sufficient volume so that their height exceeded the excavated part of the pit and they melted the upper portion of an ice wedge beneath the retaining berm; the reserve pit berm failed, releasing drilling muds and cuttings onto the ice of Teshekpuk Lake and adjoining low areas. To prevent further discharge to the lake, the fluid from the reserve pit was pumped onto the pad. Rehabilitation included recontouring of the pad and backfilling the reserve, flare, and fuel pits with material from the pad and berms. The site was seeded and fertilized in 1978. Water-quality samples were collected by USGS in August 1983 and by the Nuera Reclamation Company in July 1984. This wellsite was visited in 1989 and 1990.

PREVIOUS WATER-QUALITY DATA FOR TESHEKPUK LAKE

Date	Temperature (°C)	pH	Specific conductance (µS/cm)	Reference
8/17/83	6.0	8.0	240	USGS* (1984)
7/20/84	8.0	8.1	145	Nuera Reclamation Company (1986, p. 22)

*Unpublished data on file in the District Office of the U.S. Geological Survey, Anchorage, Alaska.

Drilling Pad: Material for the thick pad and berms (mostly fine-to-medium sands) were obtained from excavation of the reserve pit and a borrow site 5.3 mi southwest of the site at the mouth of Kealok Creek.

Reserve, Flare, and Fuel Pits: The backfilled reserve pit is breached in the northeastern corner and did not contain water in August 1983. In 1989, however, about 1.7 ft of water remained over the fill on the western side of the reserve pit. The flare pit is also backfilled. A breach allows meltwater and precipitation to run off; the flare pit did not contain water in August 1983. The fuel pit has been backfilled.

Adjacent Areas: Erosion along the shore of Teshekpuk Lake is removing materials from the flare pit area.

Summary of Reconnaissance Visits

Flow is to the north and the south toward both shores of the peninsula. Vegetation is sparse. Erosion along the lake is actively removing materials from part of the flare pit and the reserve pit berm on the northeast corner of the site.

The electromagnetic survey in 1989 indicated that background earth conductivity values were 3.2 to 4.2 mS/m (plate 8B). Earth-conductivity values along the western side of the pad and reserve pit were slightly higher, in the range of 5 to 9 mS/m. These higher values appear to indicate some leakage from the reserve pit westward. Specific conductance of water in ponds around East Teshekpuk ranged from 453 to 666 µS/cm. Water samples from SL 5 and SL 5A, however, had specific conductances of 2,200 and 1,190 µS/cm, respectively. SL 5A (plate 8D), was chosen for the wellsite after observations during the spring of 1990 indicated that SL 5, selected in 1989, was not in the flow path of runoff. The specific conductance of water in a sample collected from the lake in 1989 was 143 µS/cm. Specific conductance of water in three additional samples from the lake in 1990 ranged from 217 to 228 µS/cm.

A brief reconnaissance survey for soil gas in 1989 indicated elevated concentrations in the flare pit (plate 8C). A more detailed survey of the flare pit in 1990 indicated significant soil-gas concentrations in the flare pit and surrounding area (plate 8E). Two soil samples were collected from the flare pit in 1989 and six in 1990. TPH concentrations ranged from 34 to 25,000 mg/kg; only two of the eight samples had concentrations below 80 mg/kg.

A gas chromatograph was used in 1990 to analyze 25 soil and 3 water samples. One water sample contained a detectable quantity of a single VOC at an apparently low concentration (table 12-ET in the appendix). Thirteen soil samples contained detectable quantities of both single and multiple VOCs.

The pH of water in the lake ranged from 7.1 to 8.6. In 1989, barium was detected in the soil sample at SL 10 at a concentration of 7,890 mg/kg and in a sediment sample about 25 ft offshore in Teshekpuk Lake at a concentration of 5,350 mg/kg. Additional high concentrations of barium in sediment were detected in samples from SL 10-1 and SL 7. Large concentrations of chromium, ranging from 19.6 to 43 mg/kg, were also detected in these samples. Concentrations of TPH in sediment were 25,000 mg/kg in SL 10, 9,100 mg/kg in SL 10-1, 6,500 mg/kg in the Teshekpuk Lake sample, and 330 mg/kg in SL 5. Chromium in lake water near the wellsite in 1989 was detected slightly in excess of the MCL. This value could not be confirmed in 1990, however.

In the flare pit during the 1990 sampling, concentrations of BTEX in sediment exceeded the MCL of 1 mg/kg in FP1, FP1-1, and FP2-1 duplicate. Concentrations of barium above 1,000 mg/kg were detected in samples SL 3A-3 in the reserve pit (closer to the wellhead than SL 3), in FP1, and at lake station 8. Chromium concentrations were 45.2 mg/kg at SL 3A-3 and 19.2 mg/kg at FP1. The concentration of TPH in a water sample from lake station 16 was 4.5 mg/L. The concentration of TPH in sediments at SL 10, near the place where the flare pit is eroding into the lake, was 13,100 mg/kg. Additional 1990 sampling of the flare pit area confirmed generally high concentrations of TPH. The TPH concentration was 114 mg/kg at SL 3A-3 and 88 mg/kg at SL 5. Three lake sediment samples collected within 25 ft of the shore where the flare pit is eroding into Teshekpuk Lake had TPH concentrations of 80 mg/kg at Teshekpuk Lake station 11, 106 mg/kg at station 13, and 230 mg/kg at station 14.

USEPA (1986b) has established maximum contaminant levels for many elements for the protection of fish and wildlife. The only one of these elements that appears in the analysis of samples from Teshekpuk Lake was iron, and its concentration (0.07 mg/L) was below the maximum allowable concentration of 1.0 mg/L.

East Teshekpuk was one of the sites chosen for analysis of background concentrations of TPH (fig. 7). Concentrations in sediment samples from 12 sites, all of which were more than 1 mi from the wellsite, ranged from 9.5 to 47.5 mg/kg, and the mean was 19.7.

Three land-surface profiles were surveyed along the lakeshore (figs. 8-10). The surveys and photographs indicate that erosion of the shore occurred between 1989 and 1990.

Sinclair Lake (fig. 6), a large lake between Barrow and East Teshekpuk, was sampled during the summer of 1990 for comparison with the concentrations of constituents found in Teshekpuk Lake. The barium concentration in the sediment of Sinclair Lake was 56.8 mg/kg, nearly two orders of magnitude less than the concentration of 5,350 mg/kg found in the 1989 Teshekpuk Lake sediment sample. The concentration of chromium in the sediment was 8.1 mg/kg, compared with 42.7 mg/kg in the Teshekpuk Lake 1989 sediment sample. In 1990, chromium in the Teshekpuk Lake sample ranged from "not detected" to 9.9 mg/kg. The concentration of TPH was 20.2 mg/kg in sediment, more than two orders of magnitude less than the maximum concentration found in Teshekpuk Lake near the wellsite.

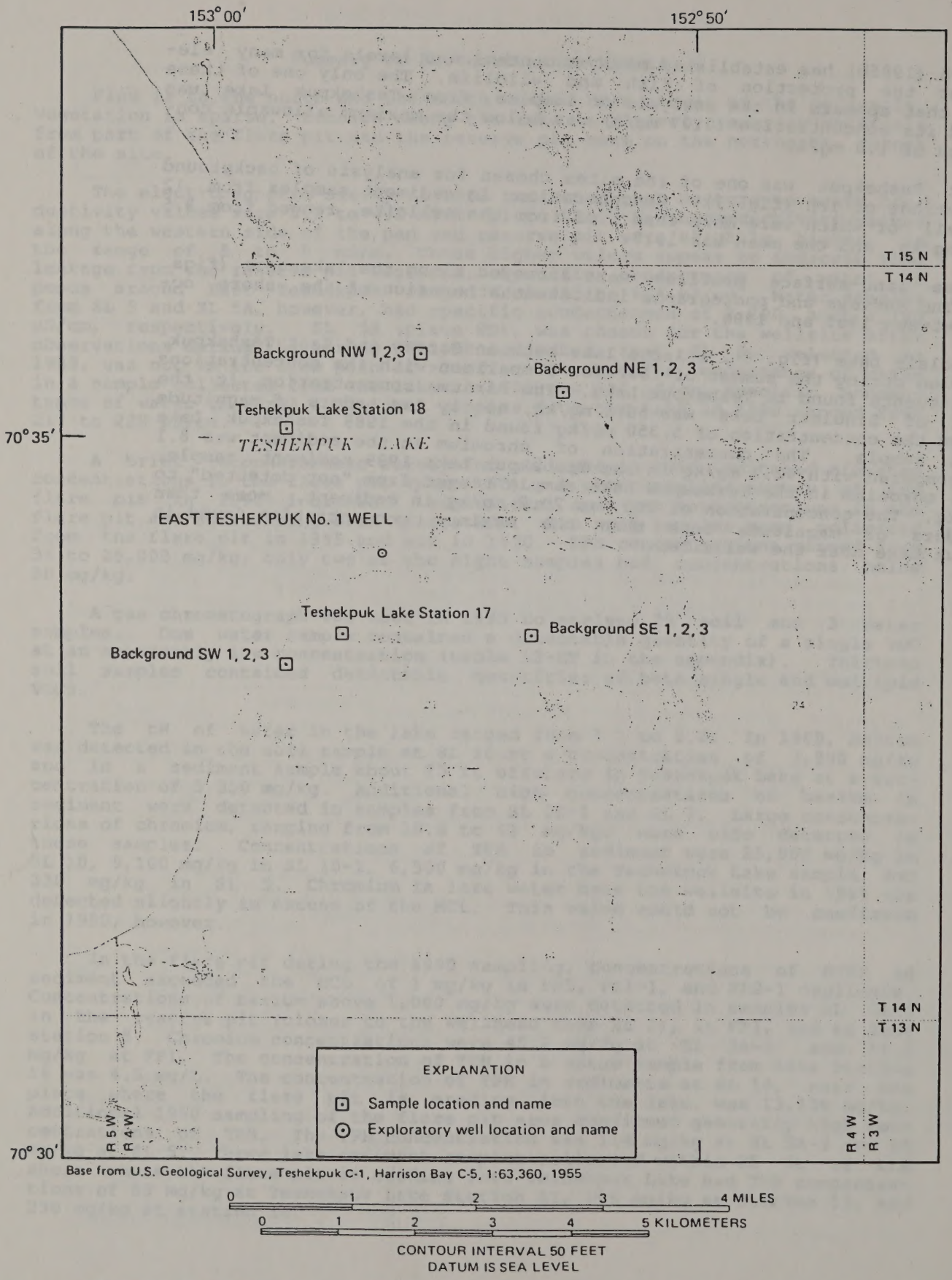


Figure 7.--East Teshekpuk No. 1 well and background sample locations and Teshekpuk Lake station 17 and 18 sample locations.

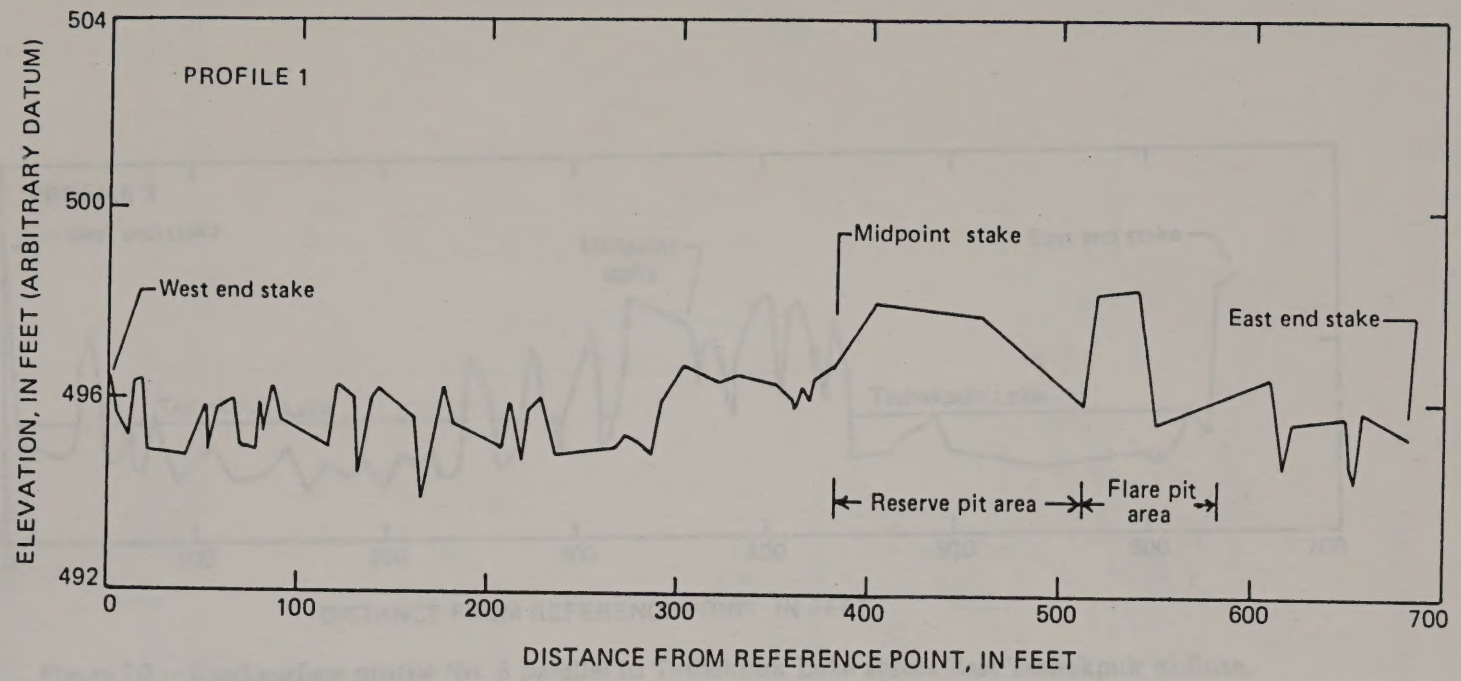


Figure 8.--Land-surface profile No. 1 parallel to Teshekpuk Lake across East Teshekpuk wellsite. Trace of profile shown on Plate 8D.

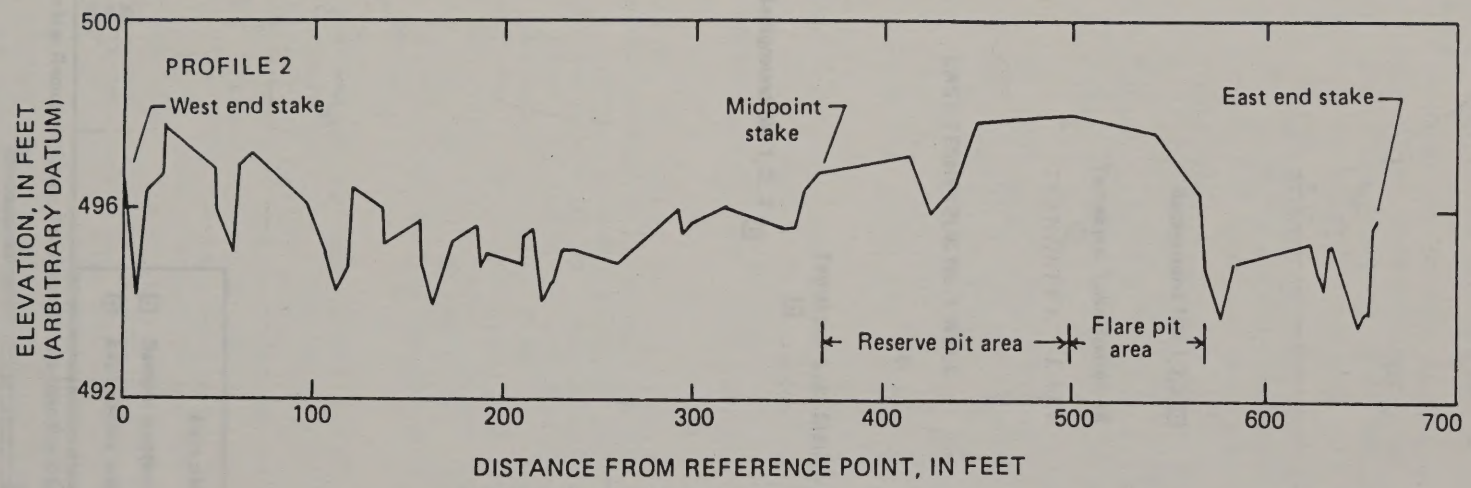


Figure 9. -- Land-surface profile No. 2 parallel to Teshekpuk Lake across East Teshekpuk wellsite. Trace of profile shown on Plate 8D.

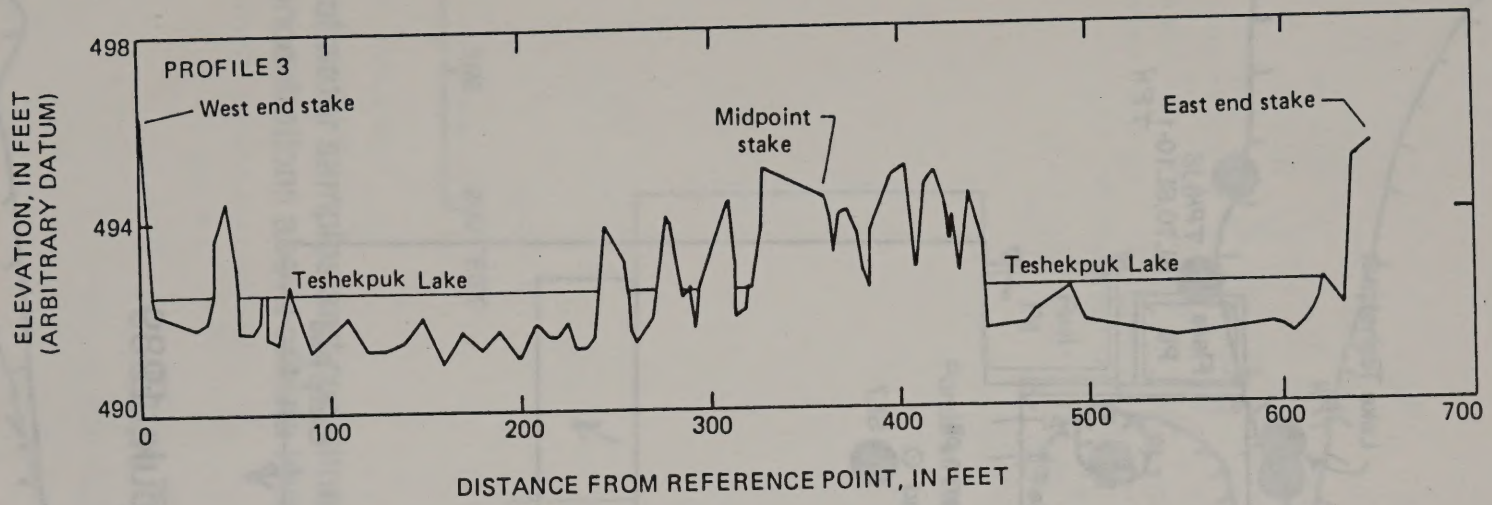
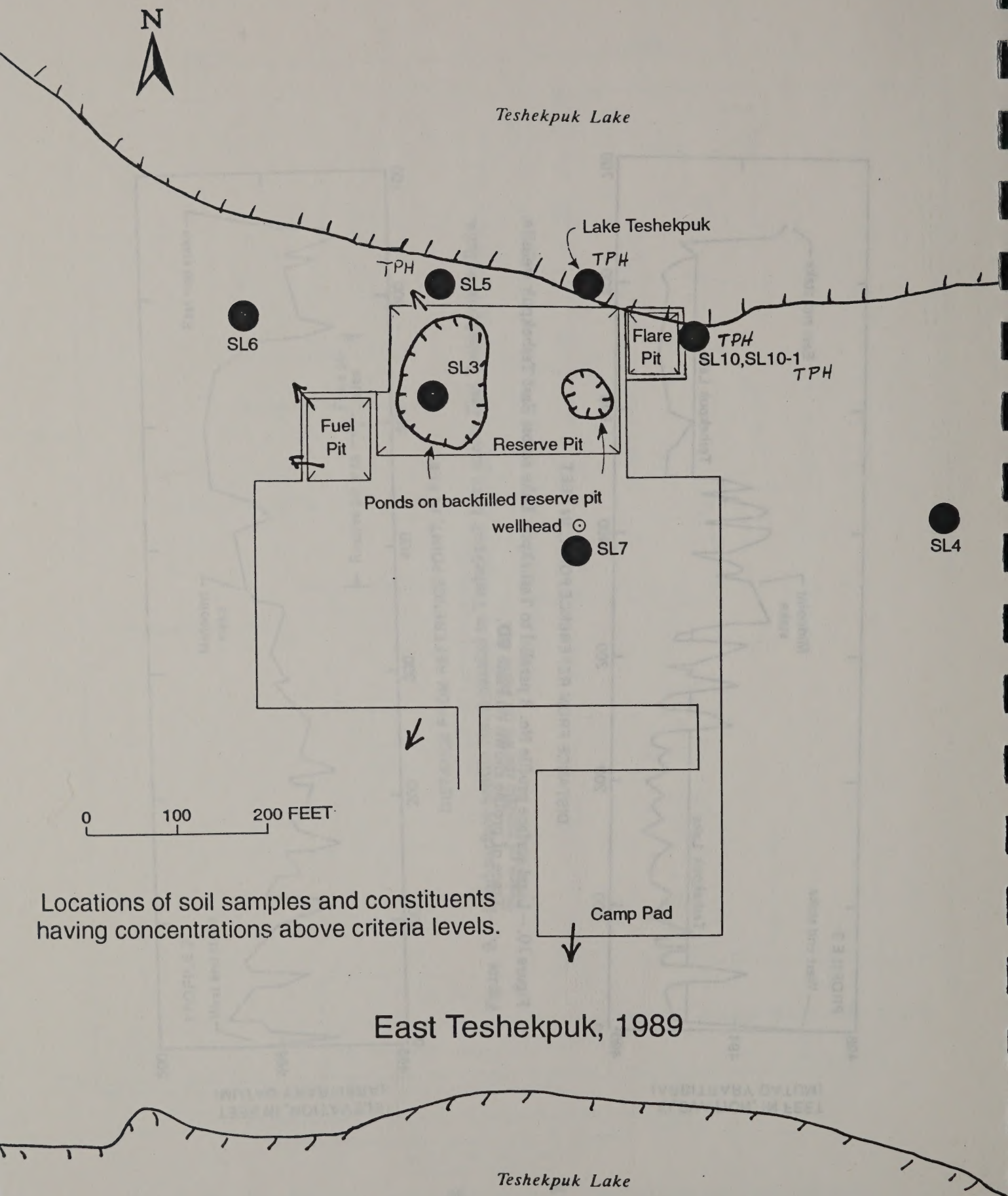
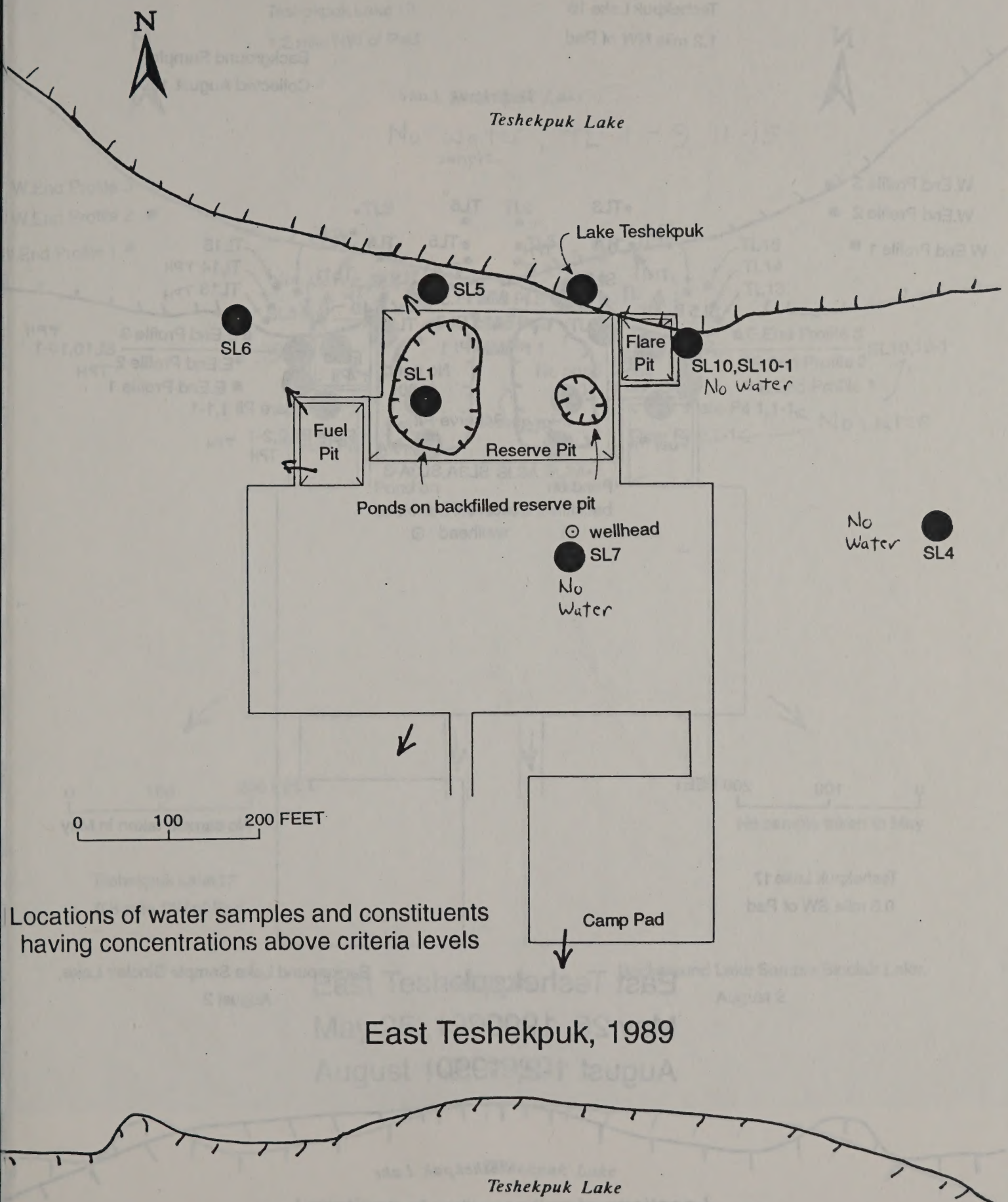


Figure 10.--Land-surface profile No. 3 parallel to Teshekpuk Lake across East Teshekpuk wellsite. Trace of profile shown on Plate 8D.



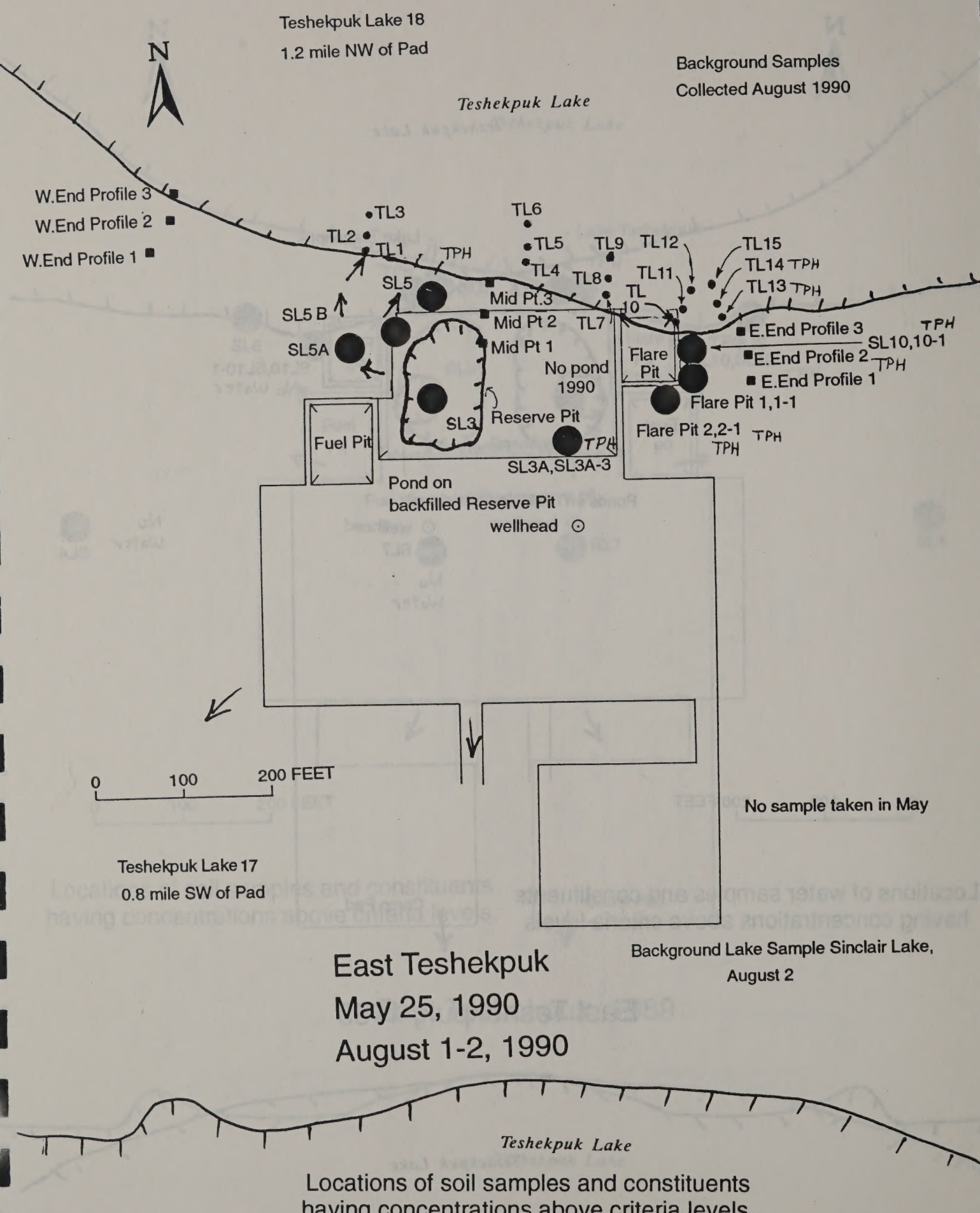
Locations of soil samples and constituents having concentrations above criteria levels.

East Teshekpuk, 1989

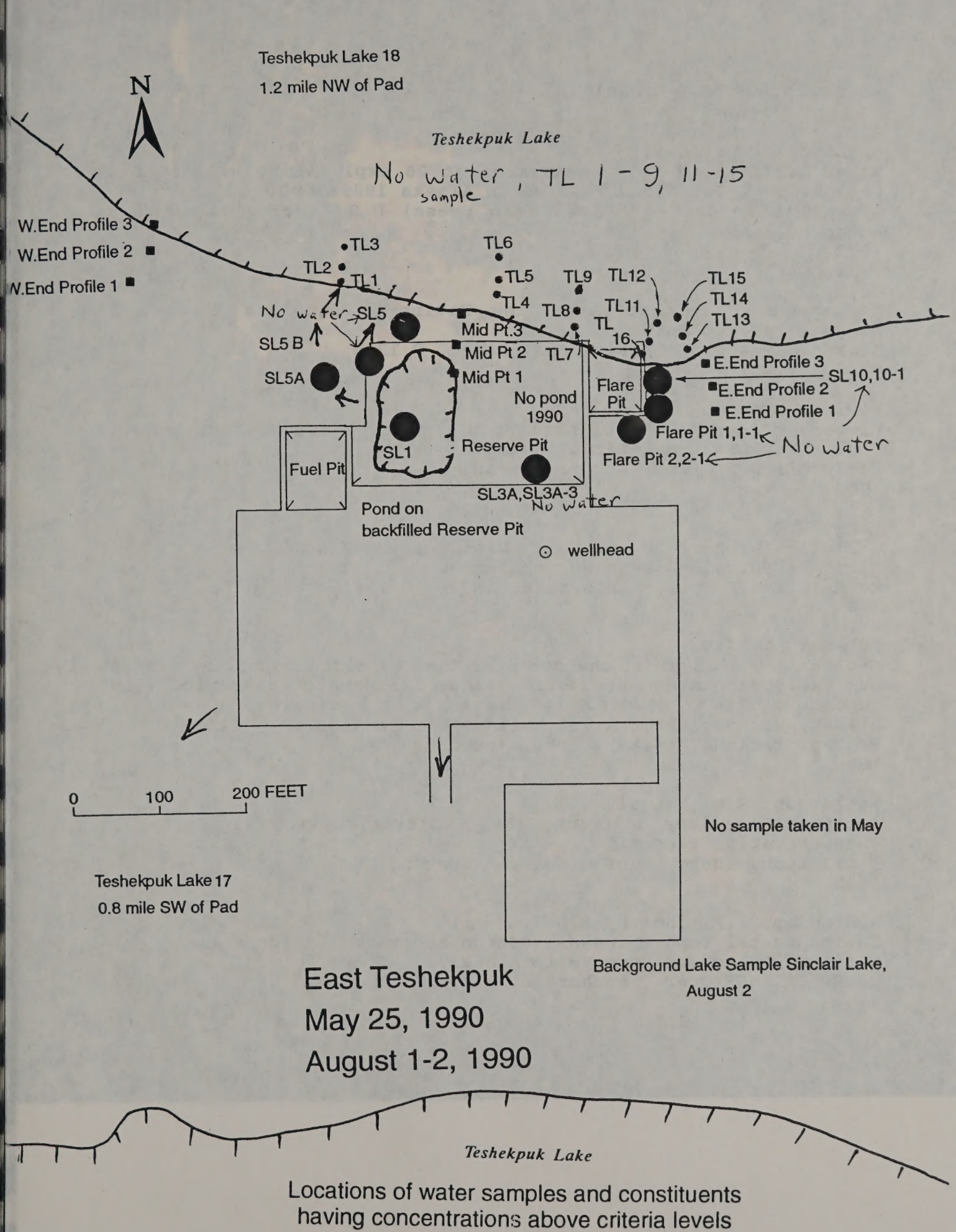


Locations of water samples and constituents having concentrations above criteria levels

East Teshekpuk, 1989



Locations of soil samples and constituents
having concentrations above criteria levels.



Locations of water samples and constituents having concentrations above criteria levels

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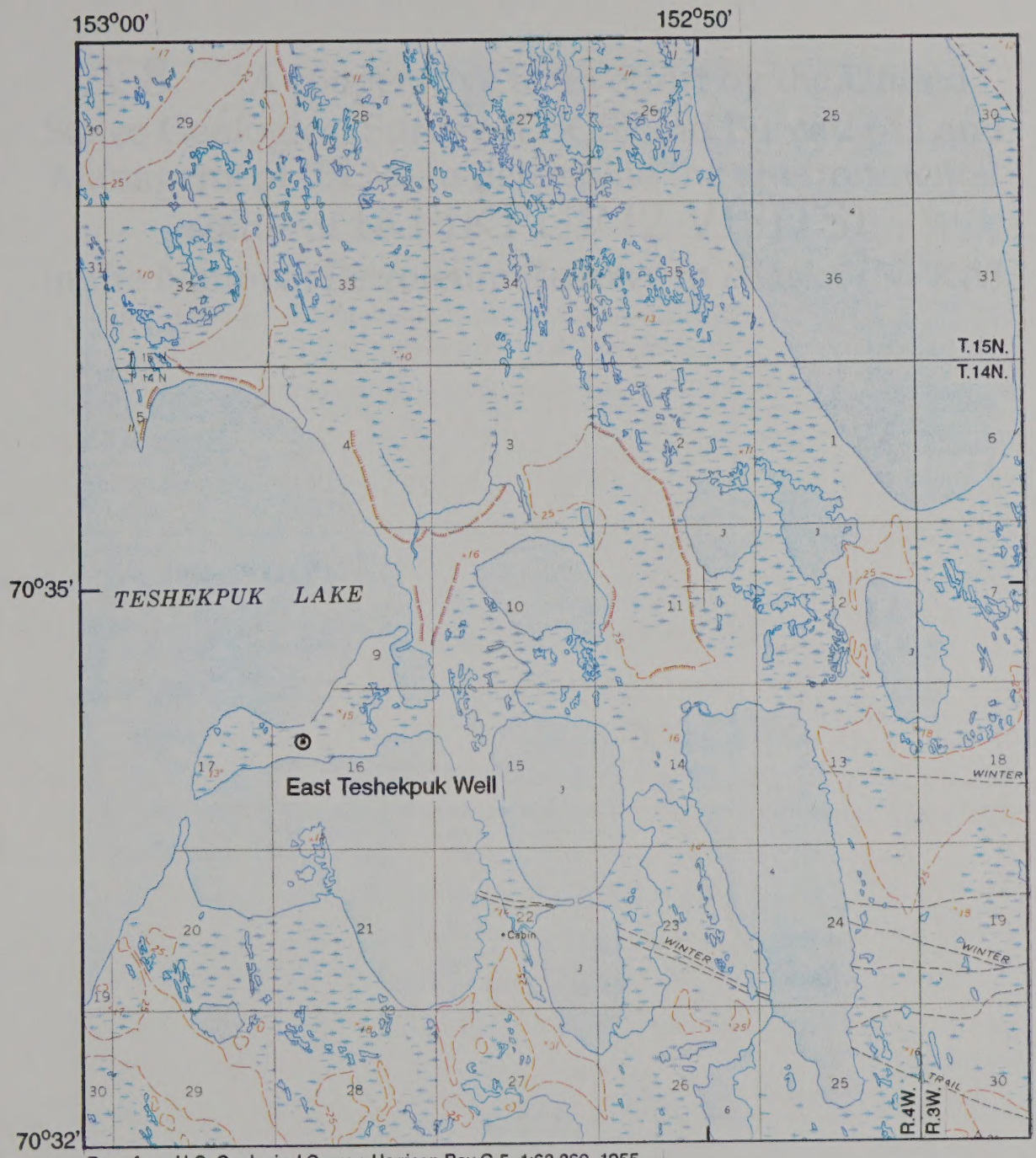


Base from U.S. Geological Survey, Harrison Bay C-5, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of East Teshekpuk well.

A-8. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of IKPIKPUP (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

8. WELLSITE RISK DETERMINATION
IKPIKPUK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA)1989,1990(USGS)
Prior Mitigation	Partially filled pit. Seeded and/or Fertilized 1980,1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Limited subsidence in pit area
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Good on pad-sparse on sandy surface
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Covered by pad materials. Up to 4 feet of water in pit. TPH, BTEX elevated above background, Chromium in the pit elevated above MCL
Other Solids	None observed
Hydrocarbon Residue	TPH, BTEX elevated above background adjacent to pit
Contaminant Level	TPH, BTEX elevated above background, Barium slightly elevated above MCL(1990 data). Chromium elevated above MCL but high natural background levels
Contaminant Migration	Low level moving offsite from pit to adjacent area
Contaminant Persistence	TPH Associated with sediments. Contaminants detected-some mobility but limited. Site is more than 12 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

Ikpikpuk

Location and Drilling Characteristics

Latitude: 70°27′19.68" *Longitude*: 154°19′52.78"

Location: T. 13 N., R. 10 W., Sec. 25 NE 1/4, Umiat Meridian

Depth: 15,481 ft *Drilled*: 11/28/78 - 4/17/79 and 2/24/79 - 2/28/80

Description

Ikpikpuk Test Well No. 1 (plate 9A), located 10 mi southwest of Teshekpuk Lake and 80 mi southeast of Barrow, occupies a drained lake basin containing low-centered polygons and little topographic relief. The pad was constructed in January and February 1978; drilling was done during the next two winter seasons and was suspended during summer. The pad was lowered and recontoured by pushing material into the reserve pit. The site was seeded and fertilized in 1980 and fertilized again in 1982. Water-quality samples were collected by the Nuera Reclamation Company in July 1984. The wellsite was visited in both 1989 and 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/4/84	12.0-13.0 °C	8.4	1,290-1,320 µS/cm	Nuera Reclamation Company (1986, p. 29-30)

Drilling Pad: Material for the berms and thick pad was excavated from the reserve pit, two borrow sites about 1 mi south and 1 mi west of the wellsite, and a sand bluff on a tributary of the Ikpikpuk River.

Reserve and Flare Pits: Backfill placed in the reserve pit has settled. Water depth ranged from 2.5 to 4 ft on July 4, 1984. Large breaches in the berm on the northern, eastern, and western sides of the reserve pit allow exchange of water with the surrounding terrain. Arctic Pack (JP5 fuel) was injected into the well during the summer shutdown in 1979. The Arctic Pack was burned in the flare pit in the fall of 1979 when drilling resumed. A breach in the reserve pit is the principal route by which water leaves the wellsite.

Adjacent Areas: Vegetation damage is evident in the adjacent area of approximately 1,000 ft^2 (Nuera Reclamation Company, 1986).

Summary of Reconnaissance Visits

Ikpikpuk is a sandy site situated on a low divide. Flow of water is both to the east and to the west, but more of the area drains to the west than to the east. Grasses are well established at the site and the revegetation is good, except where erosion by wind has prevented growth. Wind erosion has occurred over about one-third of the pad. Deposition of sand has occurred adjacent to the pad on the downwind (northwest) side.

The electromagnetic survey demonstrated background values in the range of 2 to 3 mS/m (plate 9B). Slightly higher values on the western side indicate the dominant direction of transport of higher specific-conductance water from the reserve pit. The specific conductance of water in the

reserve pit was 1,380 µS/cm, which was significantly higher than that in background ponds. Background Ponds H, K, L, and O had water of specific conductance 140, 199, 78, and 305 µS/cm, respectively.

A soil-gas survey was not done in 1989. In 1990, elevated organic-vapor concentrations were detected in mid-pad and near the fuel storage area (plate 9D). Soil sample FP was collected from the fuel pit in May 1990; a sample from the fuel pit at site FP2 was collected in July 1990.

The wellsite was visited in May 1990 to observe flow conditions and to measure specific conductance of the water (plate 9C). During that visit, about 0.2 ft of sand was observed on the ice, about 2 to 4 ft away from the berms. It appears that the sand had eroded off the berms. Water was running off the pad into the reserve pit, and the pit was filling. Flow away from the pit was not evident, however.

In July 1990, the wellsite was visited again to collect samples to confirm the presence of high concentrations of TPH and chromium. Elevated concentrations had been detected during the 1989 visit.

The pH of water in the reserve pit in 1989 was 8.9, and water in most other ponds was also slightly alkaline. Ground-water samples, however, were slightly acidic, with pH ranging from 5.8 to 7.0. No significant differences in pH were observed in 1990.

In 1989, the concentration of chromium (3.0 mg/L) in water collected at SL 4, 200 ft upgradient from the reserve pit, exceeded the MCL. Resampling at this site in 1990 yielded the following chromium concentrations, all of which were below the MCL:

Sample point	Concentration of chromium (mg/L)
SL 4B	0.025
SL 4C	.028
SL C	.014
SL E	.028

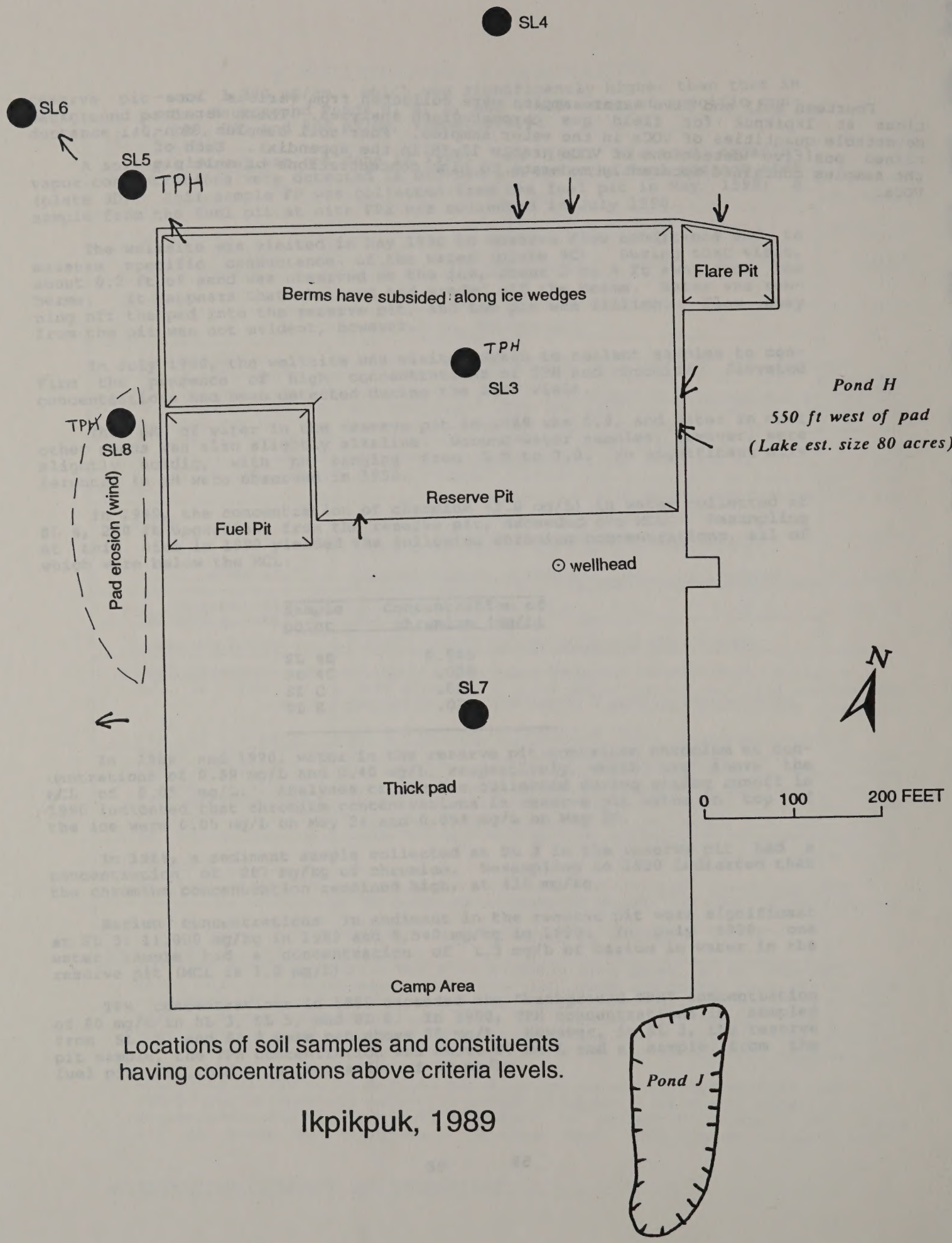
In 1989 and 1990, water in the reserve pit contained chromium at concentrations of 0.39 mg/L and 0.40 mg/L, respectively, which are above the MCL of 0.05 mg/L. Analyses of samples collected during spring runoff in 1990 indicated that chromium concentrations in reserve pit water on top of the ice were 0.05 mg/L on May 24 and 0.094 mg/L on May 29.

In 1989, a sediment sample collected at SL 3 in the reserve pit had a concentration of 287 mg/kg of chromium. Resampling in 1990 indicated that the chromium concentration remained high, at 436 mg/kg.

Barium concentrations in sediment in the reserve pit were significant at SL 3: 11,000 mg/kg in 1989 and 8,540 mg/kg in 1990. In July 1990, one water sample had a concentration of 1.3 mg/L of barium in water in the reserve pit (MCL is 1.0 mg/L).

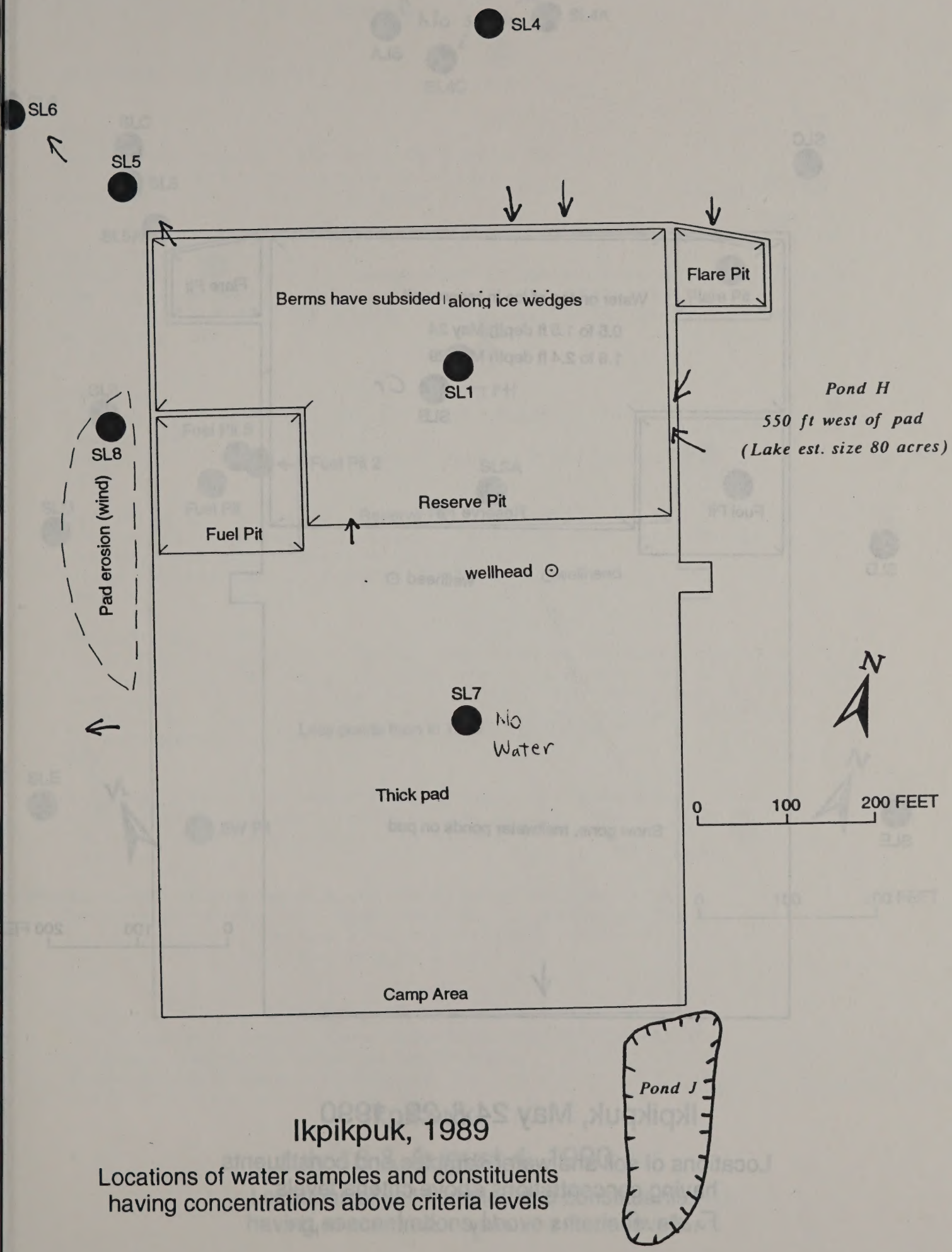
TPH concentrations in 1989 exceeded the "background TPH" concentration of 80 mg/L in SL 3, SL 5, and SL 8. In 1990, TPH concentrations in samples from SL 5 and SL 8 were not above 80 mg/L. However, in SL 3, the reserve pit sample, the TPH concentration was above 80 mg/L and a sample from the fuel pit, FP2, had a concentration of 82 mg/kg.

Fourteen soil and five water samples were collected from various locations at Ikpikpuk for field gas chromatograph analyses. There were no detectable quantities of VOCs in the water samples. Four soil samples contained positive detections of VOCs (table 12-IK in the appendix). Each of the samples contained apparently moderate to high concentrations of multiple VOCs.



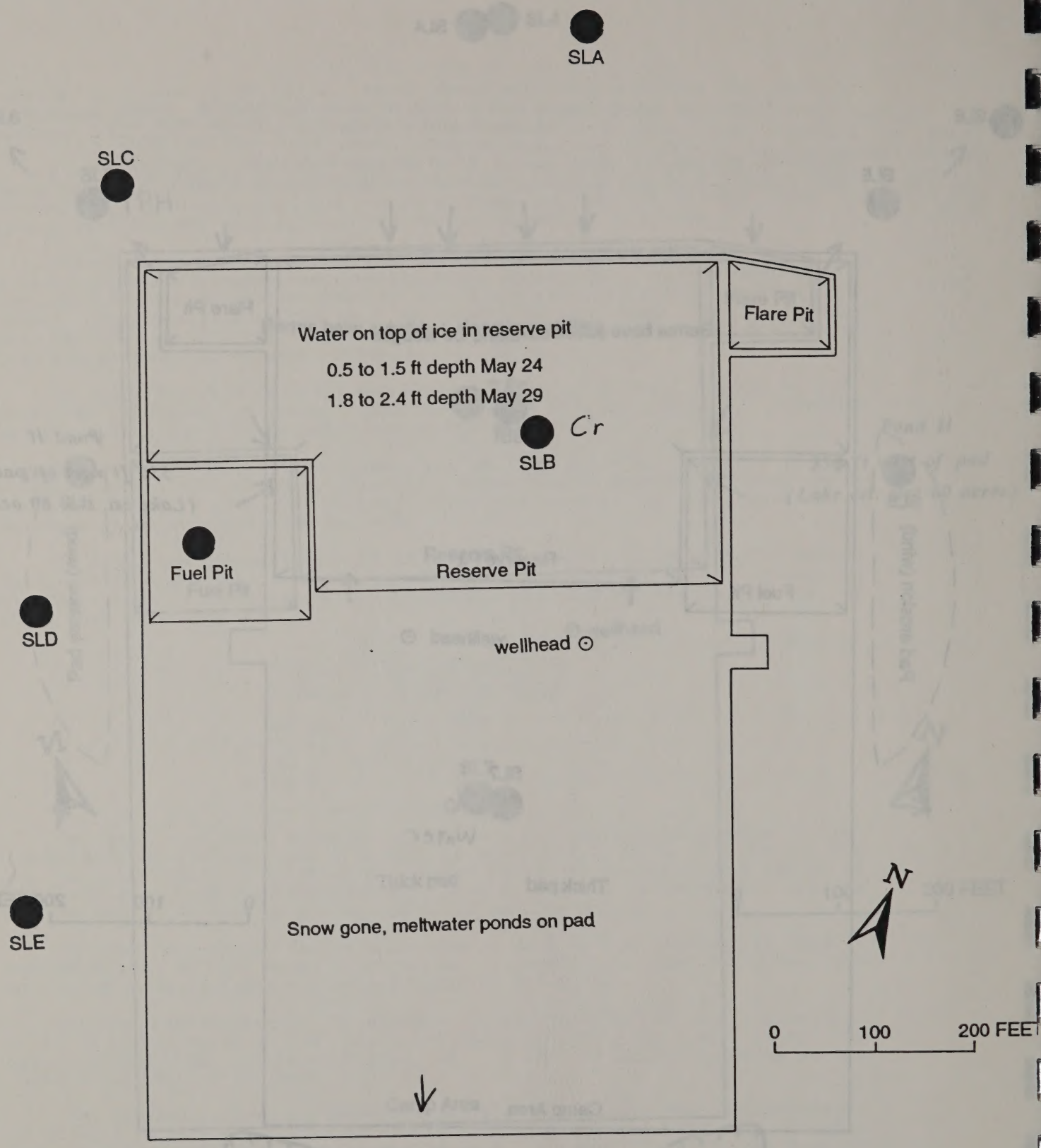
Locations of soil samples and constituents having concentrations above criteria levels.

Ikpikpuk, 1989



Ikpikpuk, 1989

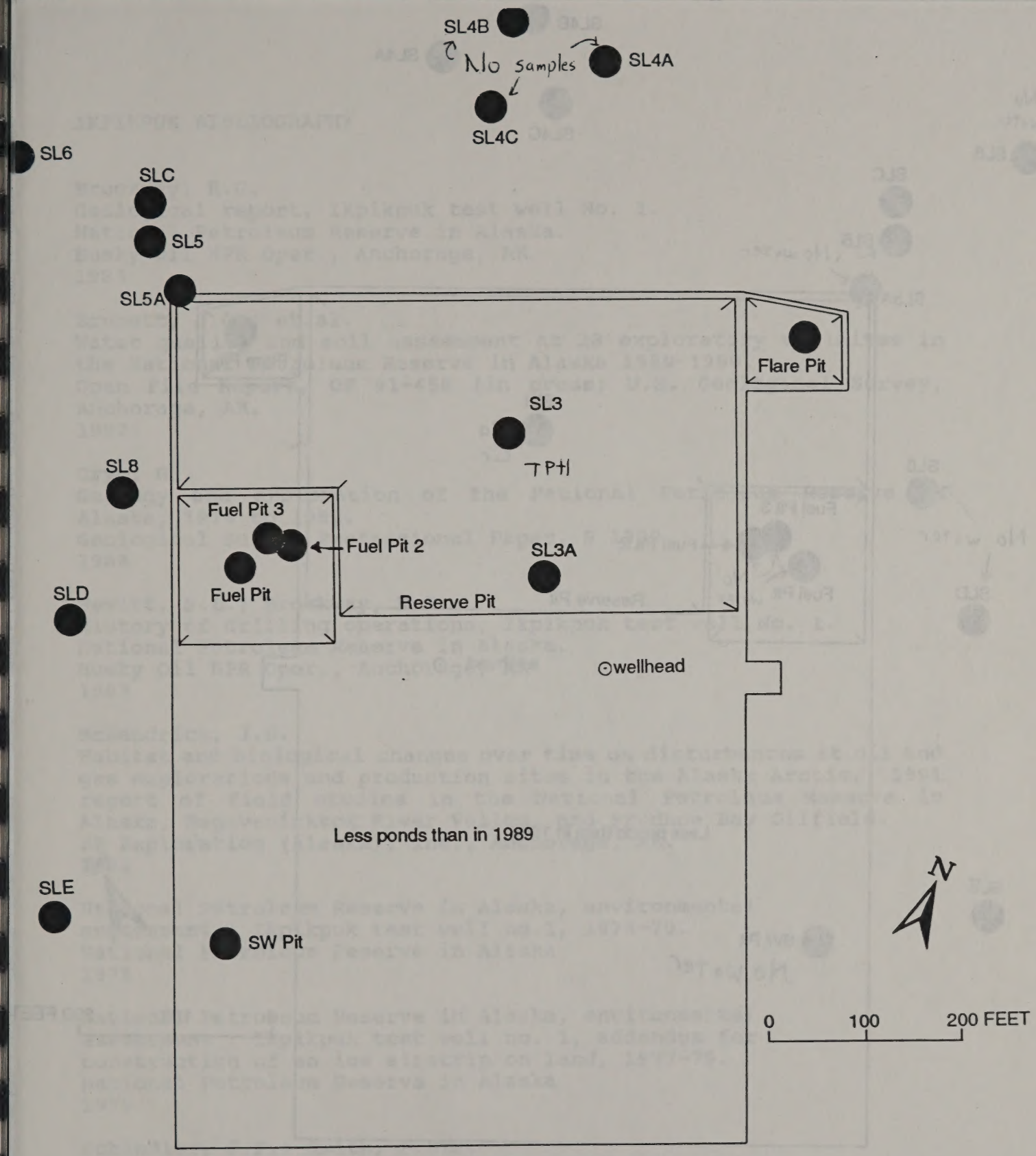
Locations of water samples and constituents having concentrations above criteria levels



Ikpikpuk, May 24 & 29, 1990

Locations of soil and water samples and constituents having concentrations above criteria levels

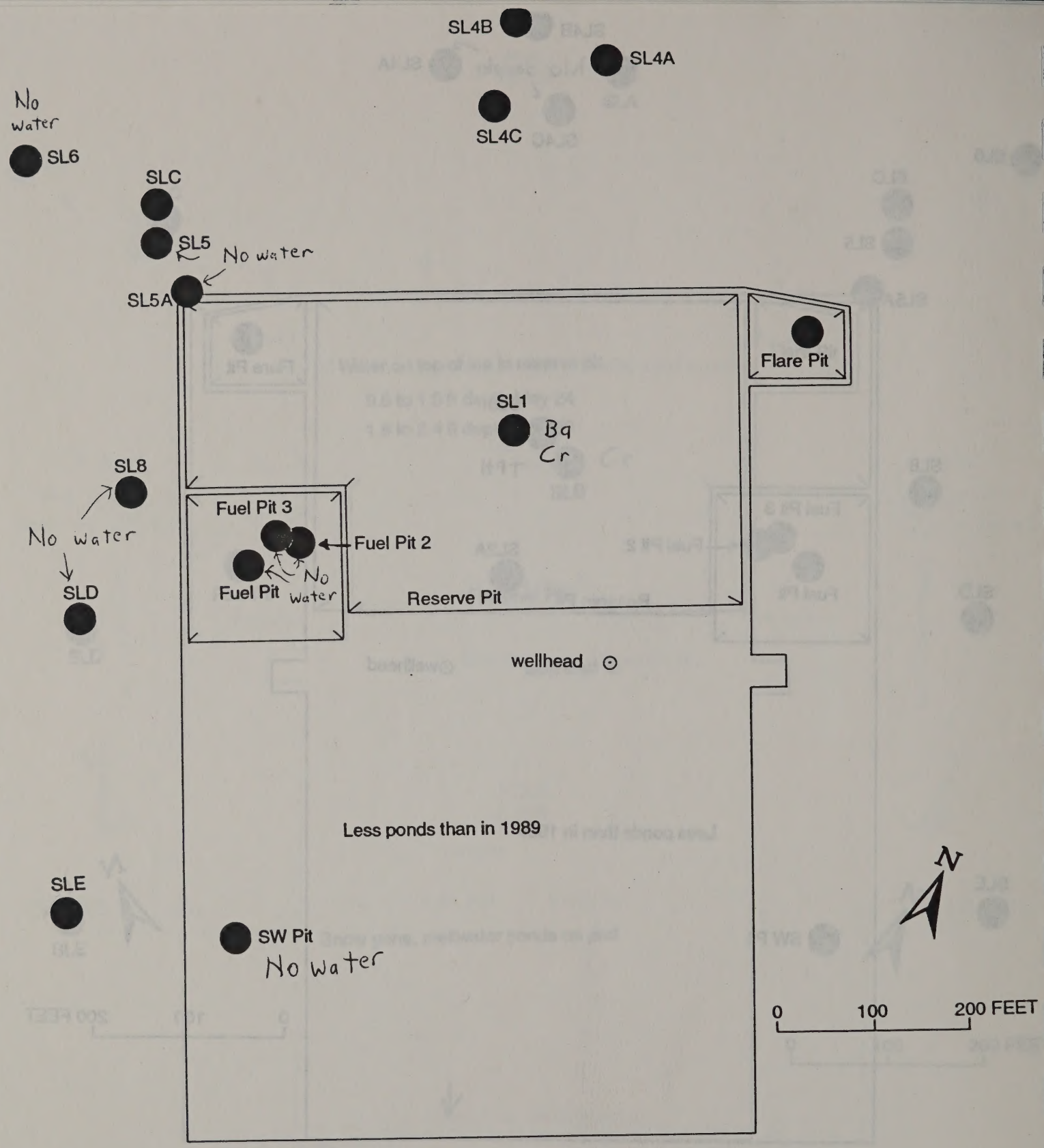
Fuel Pit is only soil sample



Ikpikpuk

July 16 & August 4, 1990

Locations of soil samples and constituents having concentrations above criteria levels.



Ikpikpuk

July 16 & August 4, 1990

Locations of water samples and constituents having concentrations above criteria levels

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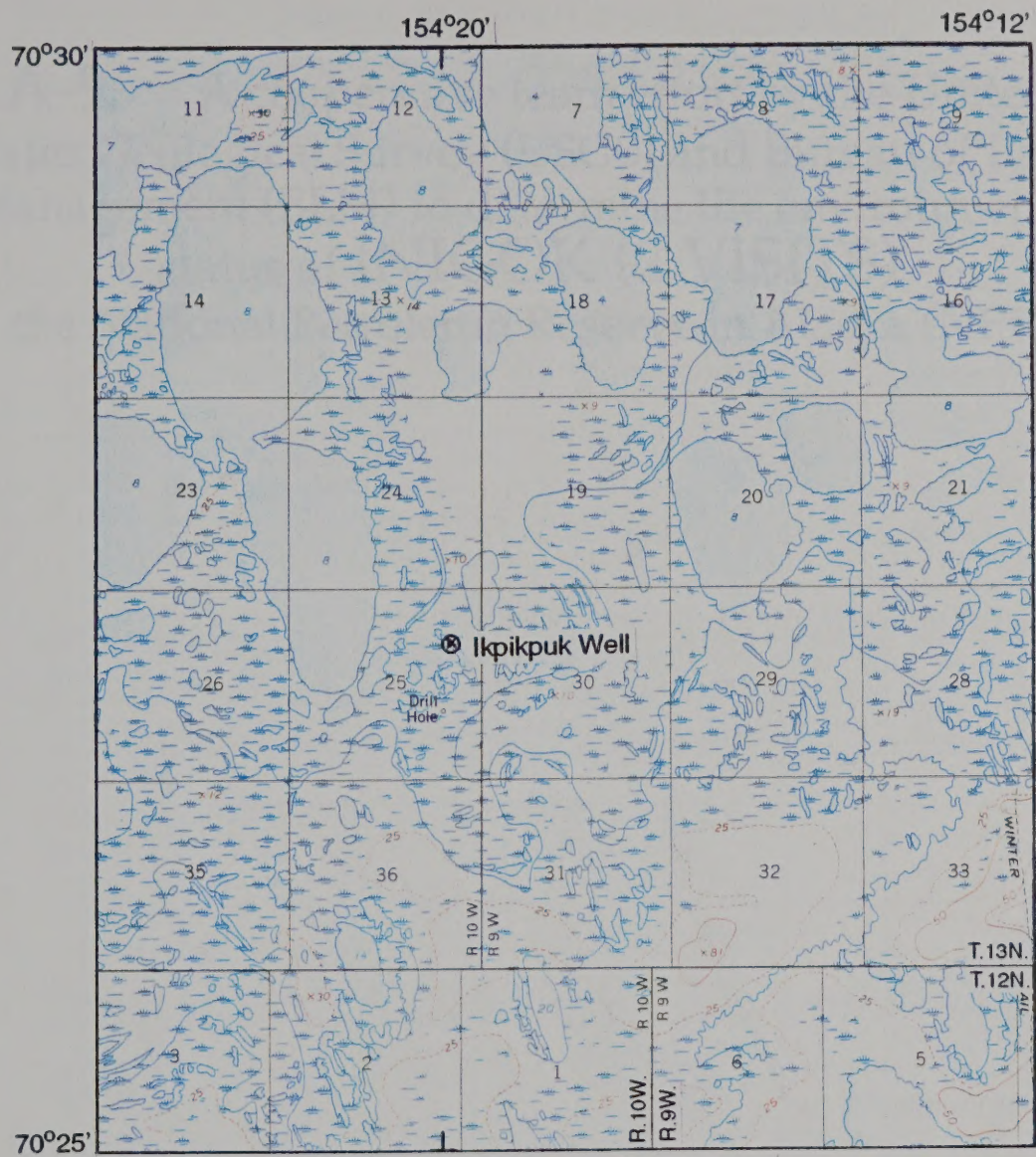
Ikpikpuk

July 16 & August 4, 1990

Location of water samples and constituents having concentrations above criteria levels

08-06-89 BLM 1:3000 IKPIKPUK 14-3-2



Base from U.S. Geological Survey, Teshekpuk B-3, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of Ikpikpuk well.

A-9. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of INIGOK (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

9. WELLSITE RISK DETERMINATION
INIGOK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1979, 1981, 1982 (NORTHERN TESTING LABS),1983,1989,1990(USGS), 1984(NUERA).
Prior Mitigation	Partially backfilled. Seeded and/or Fertilized 1980,1981,1982
Leakage/Seepage	Pits draining into lake inlet
Erosion	None
Subsidence	None
Natural Processes	Expression of natural polygons returning on uninsulated portion of pad surface
General Site Characteristics	
Vegetation	Tall but sparse on gravel pad . Stressed vegetation surrounding reserve pit
Natural Processes	Road and pad modifying natural drainage patterns
Waste	
Drilling	Drilling cuttings partially covered by sand from pad. Sulfur, Chromium and Fluoride elevated above MCL. TPH elevated above background
Other Solids	General trash
Hydrocarbon Residue	High TPH concentrations in reserve pit sediment
Contaminant Level	TPH elevated above background, chromium elevated above MCL. Fluoride elevated above MCL
Contaminant Migration	Drilling mud leachates were detected 200 feet down gradient, however concentrations are below detection in the lake
Contaminant Persistence	Associated with sediments. Site more than 13 years old, materials in bottom of pit are at the same level as lake.
Risk Screening	
Risk to Fish & Wildlife	Negligible- the lake contains fish
Risk to Human Population	Periodic human occupancy in summer by hunters, but risk considered to be negligible
RISK DETERMINATION	Negligible

Inigok

Location and Drilling Characteristics

Latitude: 70°00′17.483" *Longitude*: 153°05′56.916"

Location: T. 8 N., R. 5 W., Sec. 34 NE 1/4, Umiat Meridian

Depth: 20,102 ft *Drilled*: 6/7/78 - 5/22/79

Description

Inigok Test Well No. 1 (plate 10A) is about 123 mi southeast of Barrow and 63 mi south of Lonely. Drilling was done throughout the year. A gravel airstrip was constructed near the wellsite which is adjacent to a lake. A large amount of hydrogen sulfide was encountered in the well at 17,750 ft and was persistent to the bottom. Large quantities of ferrous oxide, zinc oxide, and zinc carbonate were introduced into the drilling mud over a period of 5 months to buffer the hydrogen sulfide. Unusually large quantities of barium sulfate as barite were introduced to increase the mud weight and chlorinity was increased to as much as 60,000 ppm during the last 2 months of drilling. Drilling muds and waters in the reserve pit contain high concentrations of chromium and zinc compounds, which were used as drilling-mud additives. Water-quality samples were collected by Northern Testing Laboratories (NTL) in 1979, 1981, and 1982, by USGS in August 1983, and by the Nuera Reclamation Company in July 1984. The site was visited in both 1989 and 1990.

PREVIOUS WATER-QUALITY DATA

[Nuera, Nuera Reclamation Company; NTL, Northern Testing Laboratories; USGS, unpublished data on file in the District Office of the U.S. Geological Survey, Anchorage, Alaska]

Date	Temperature (°C)	pH	Specific conductance (µS/cm)	Remarks	Reference
			Reserve pit		
6/79	--	9.0	--	--	Nuera (1986)
8/79	--	8.2-8.3	--	--	Nuera (1986)
9/81	--	3.3	--	NaOH added on 10/2/81	Nuera (1986)
6/29/82	17.5-24.0	6.4-6.5	5,300-5,500		NTL (1982)
9/23/82	0.5-0.6	7.4-7.6	7,600		NTL (1982)
8/19/83	5.0	8.2	4,550-4,650	Coffee colored	USGS (1984)
7/08/84	10-11	7.7-8.0	2,700-2,900		Nuera (1986)

	Near wellhead	*On opposite side of wellhead*	
	Chromium concentration (mg/L)		
6/29/82	0.474	1.04	NTL (1982)
9/23/82	4.45	4.62	NTL (1982)
8/19/83	3.14	3.72	USGS (1984)
7/7/84	.998	.975	Nuera (1986)
	Zinc concentration (mg/L)		
8/19/83	11.8	1.5	USGS (1984)
7/7/84	.629	.735	Nuera (1986)

PREVIOUS WATER-QUALITY DATA--Continued

Date	Temperature (°C)	pH	Specific conductance (µS/cm)	Remarks	Reference
			Fuel pit		
7/10/84	--	--	350	--	Nuera (1986)
			Lake inlet near wellsite		
6/29/82	17.5 °C	7.4	600	--	NTL (1982)
9/23/82	1.1	7.4	230	--	NTL (1982)
8/19/83	4.5	7.8	375	At outlet	USGS (1984)
7/7/84	12.0	7.6	990	--	Nuera (1986)
7/10/84	2-11	7.3-7.4	328-5,000	--	Nuera (1986)
			Lake, distant from wellsite		
6/29/82	18.0	7.3	130	--	NTL (1982)
9/23/82	1.8	7.5	110	--	NTL (1982)
9/19/83	4.5	7.2	98	--	USGS (1984)
7/9/84	9.5-10.0	8.0-8.1	96	Offshore	Nuera (1986)

Drilling Pad: Styrofoam and a plastic cover were used in the construction of a thick insulated all-season pad. Natural materials for the pad and berms were obtained from the airstrip runway site and from the mouth of Kikiakrorak River at Colville River, 37.5 mi east of the site: 88,000 yd³ were hauled in to the wellsite. The site was seeded and (or) fertilized in 1980, 1981, and 1982.

Reserve Pit: The reserve pit was only partially backfilled. A 5-foot berm surrounds the pit and is breached on northwestern and southwestern sides. Water depth was about 4.5 ft on July 8, 1984. About 5,000 lb of NaOH were added on October 2, 1981 to increase pH.

Summary of Reconnaissance Visits

Inigok is located on a peninsula of land between two lobes of a lake that is informally called "Inigok Lake." The principal drainage out of the wellsite is through the breached flare pit into a channel that leads into the northern lobe of the lake. Breaches also exist between the fuel-storage pit and the reserve pit and between the fuel-storage pit and a pond. The breach between the fuel-storage pit and the reserve pit was above the water surface, however, during visits in 1989 and 1990.

Vegetation on the pad consists of tall but sparse grasses. Vegetation is particularly sparse in the gravel overlying the styrofoam boards buried under a "T" shaped area of the pad.

During the 1989 electromagnetic survey, background values of earth conductivity were determined to range from 1.6 to 1.8 mS/m on the southeastern side of the reserve pit (plate 10B). Earth conductivity values measured on the upgradient parts of the pit were near background. The southwestern part of the pit registered high earth conductivity, in the range of 5 to 17 mS/m, indicating the presence of high specific conductance water from the reserve pit. Water having high specific conductance was also detected near the flare pit outlet.

A soil-gas survey in 1989 around the wellhead and along the berm indicated no significant anomalies (plate 10C).

Specific conductance values of water in the reserve pit and the flare pit were similar: 4,160 and 4,540 µS/cm, respectively. Specific conductance values of water considered to be background at the wellsite were generally less than 250 µS/cm. In the outlet channel, specific conductance in water decreases rather quickly. For example, in July 1990, the specific conductance in water samples collected progressively farther from the pit were 399, 326, and 133 µS/cm (plate 10D).

The pH of water in ponds ranged from 5.5 to 8.7. The pH of groundwater samples ranged from 5.4 to 7.3.

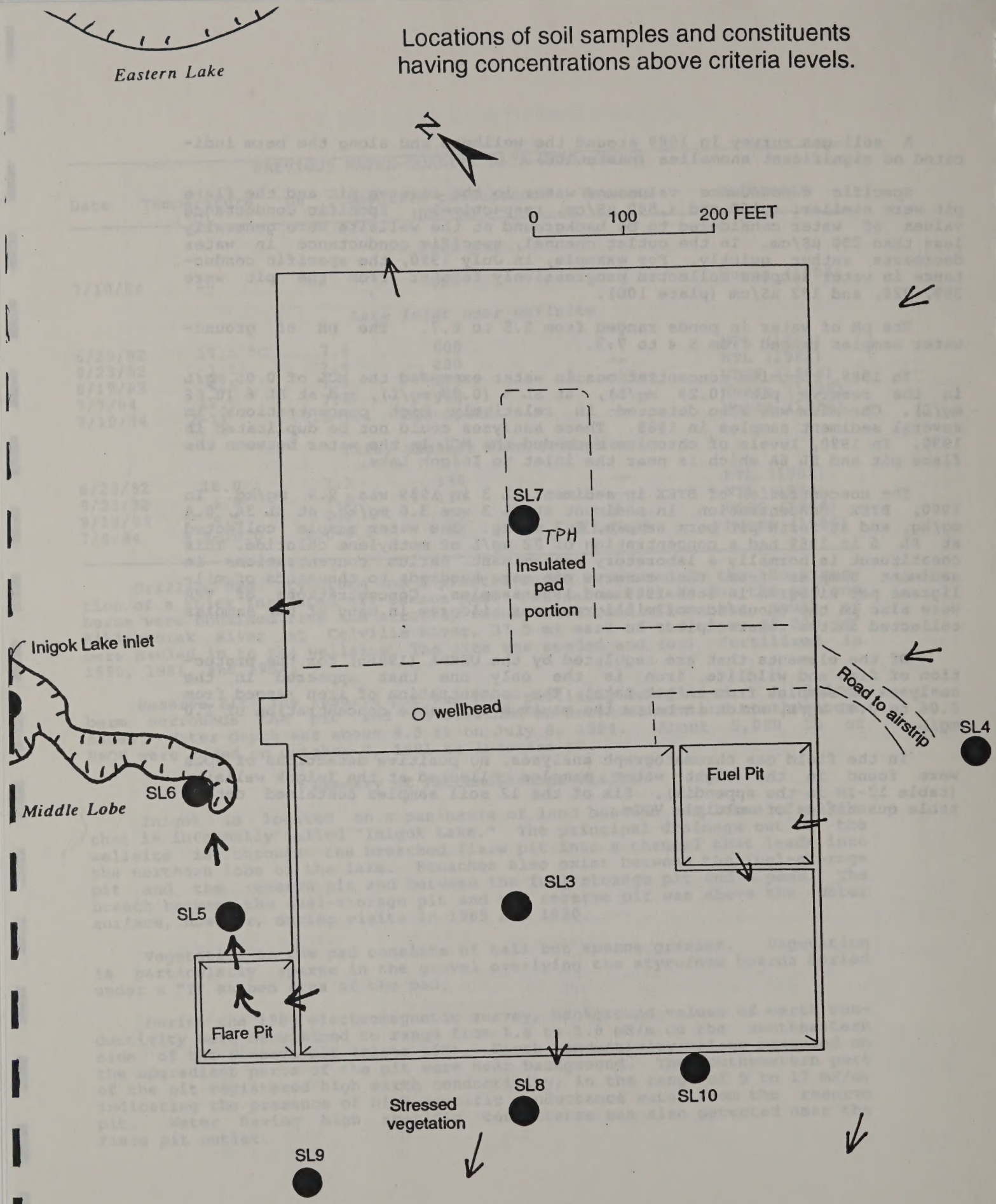
In 1989, chromium concentrations in water exceeded the MCL of 0.05 mg/L in the reserve pit (0.29 mg/L), at SL 5 (0.23 mg/L), and at SL 6 (0.06 mg/L). Chromium was also detected in relatively high concentrations in several sediment samples in 1989. These analyses could not be duplicated in 1990. In 1990, levels of chromium exceeded the MCL in the water between the flare pit and SL 6A which is near the inlet to Inigok Lake.

The concentration of BTEX in sediment SL 3 in 1989 was 9.9 mg/kg. In 1990, BTEX concentration in sediment at SL 3 was 3.0 mg/kg, at SL 3A, 8.4 mg/kg, and at north pit berm sample, 8.2 mg/kg. The water sample collected at SL 6 in 1989 had a concentration of 22 µg/L of methylene chloride. This constituent is normally a laboratory contaminant. Barium concentrations in sediment samples from the reserve pit were hundreds to thousands of milligrams per kilogram in both 1989 and 1990 samples. Concentrations of TPH were also in the thousands of milligrams per kilogram in many of the samples collected in the reserve pit.

Of the elements that are regulated by the USEPA (1986b) for the protection of fish and wildlife, iron is the only one that appeared in the analyses of samples from Inigok Lake. The concentration of iron ranged from 0.06 to 0.41 mg/L, which is below the maximum allowable concentration of 1.0 mg/L.

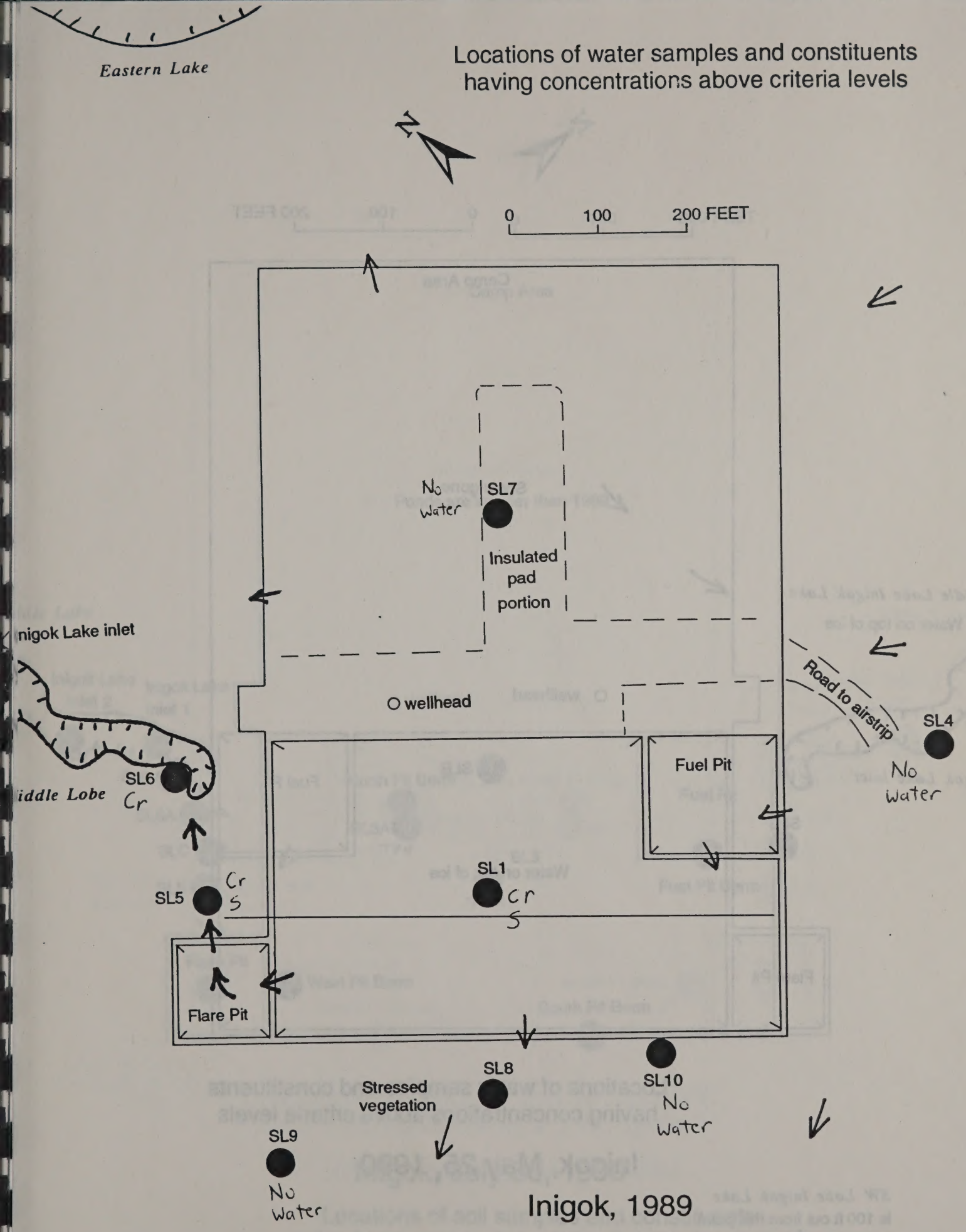
In the field gas chromatograph analyses, no positive detections of VOCs were found in the eight water samples collected at the Inigok wellsite (table 12-IN in the appendix). Six of the 12 soil samples contained detectable quantities of multiple VOCs.

Locations of soil samples and constituents having concentrations above criteria levels.

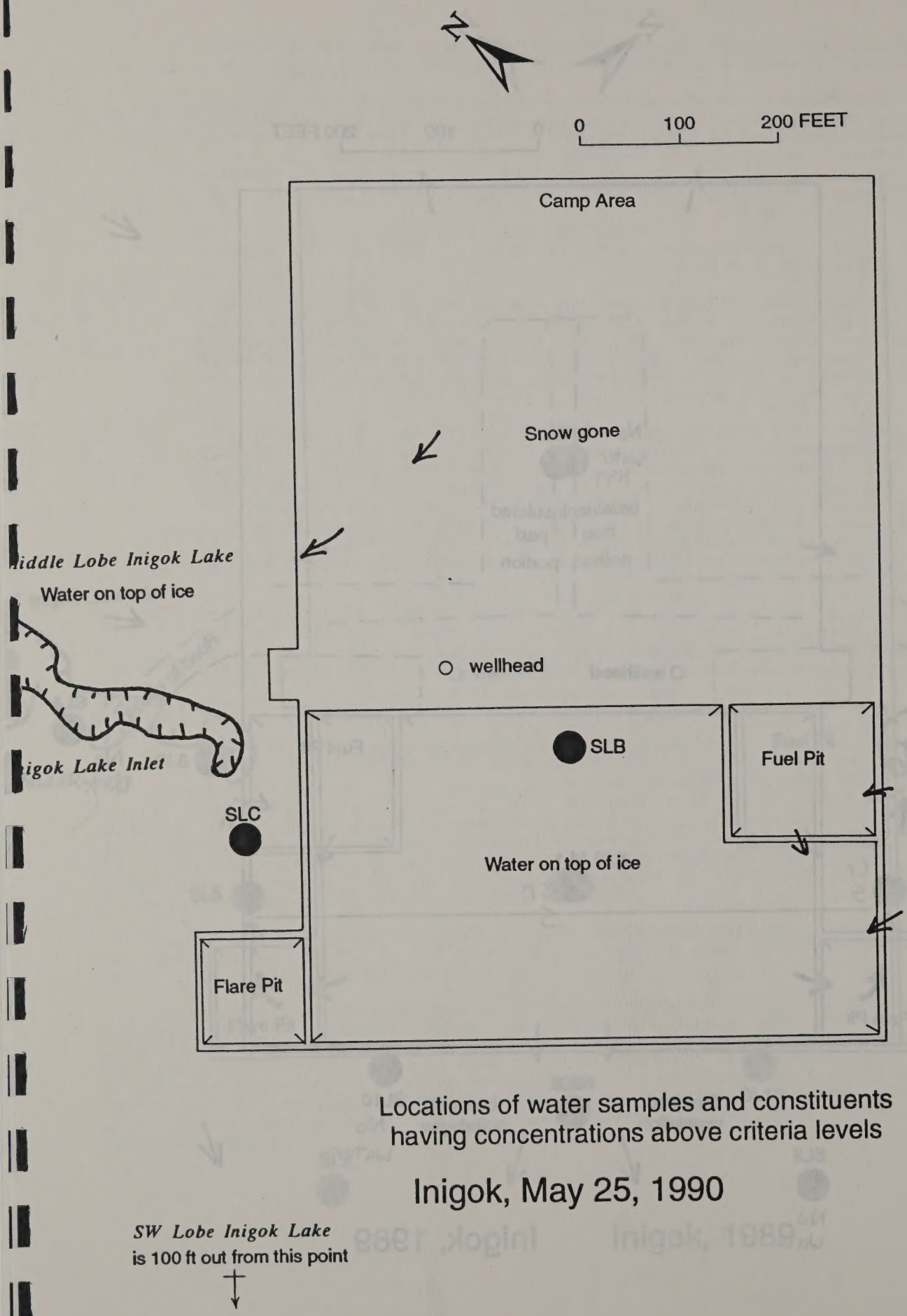


Inigok, 1989

Locations of water samples and constituents having concentrations above criteria levels

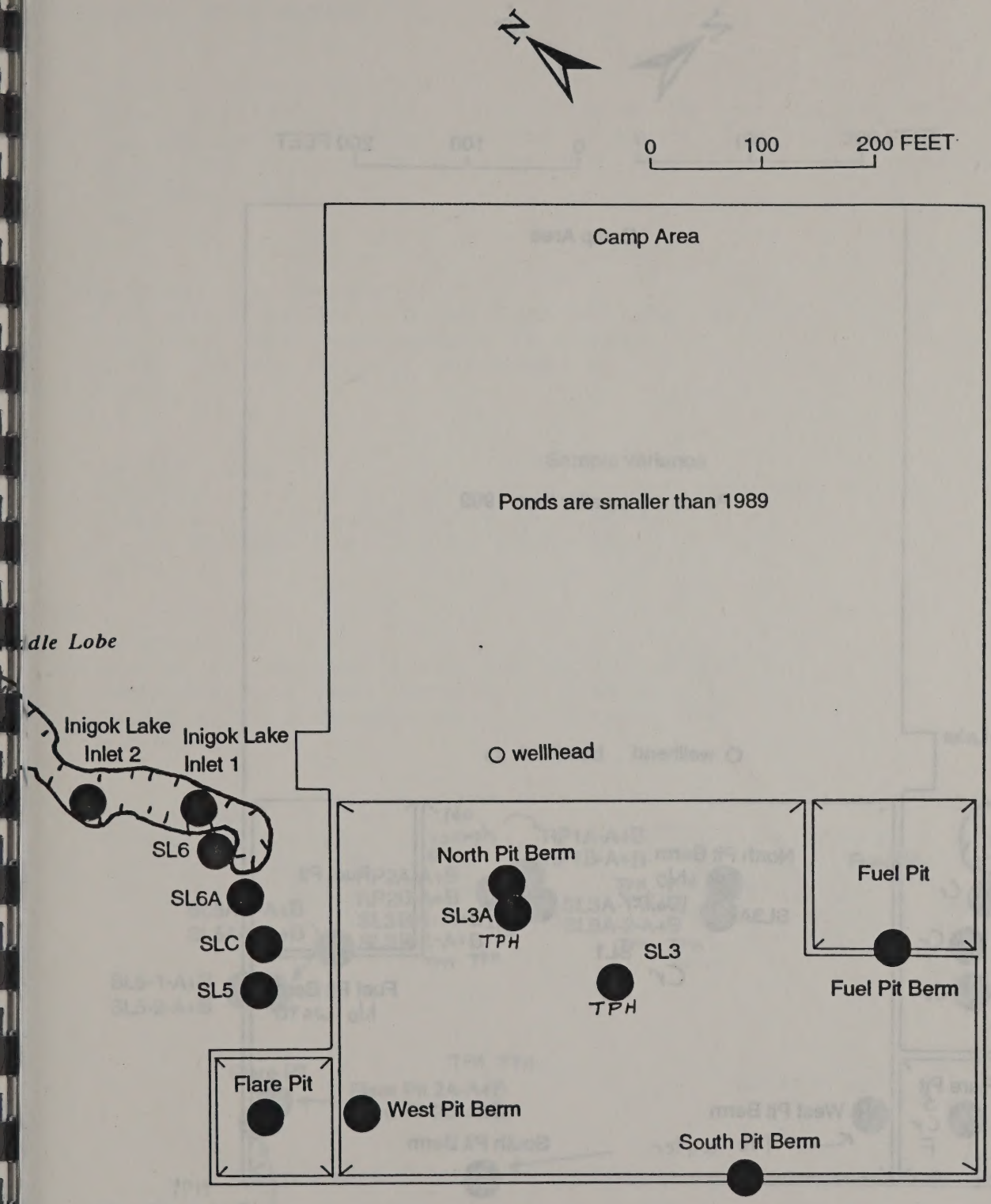


Inigok, 1989



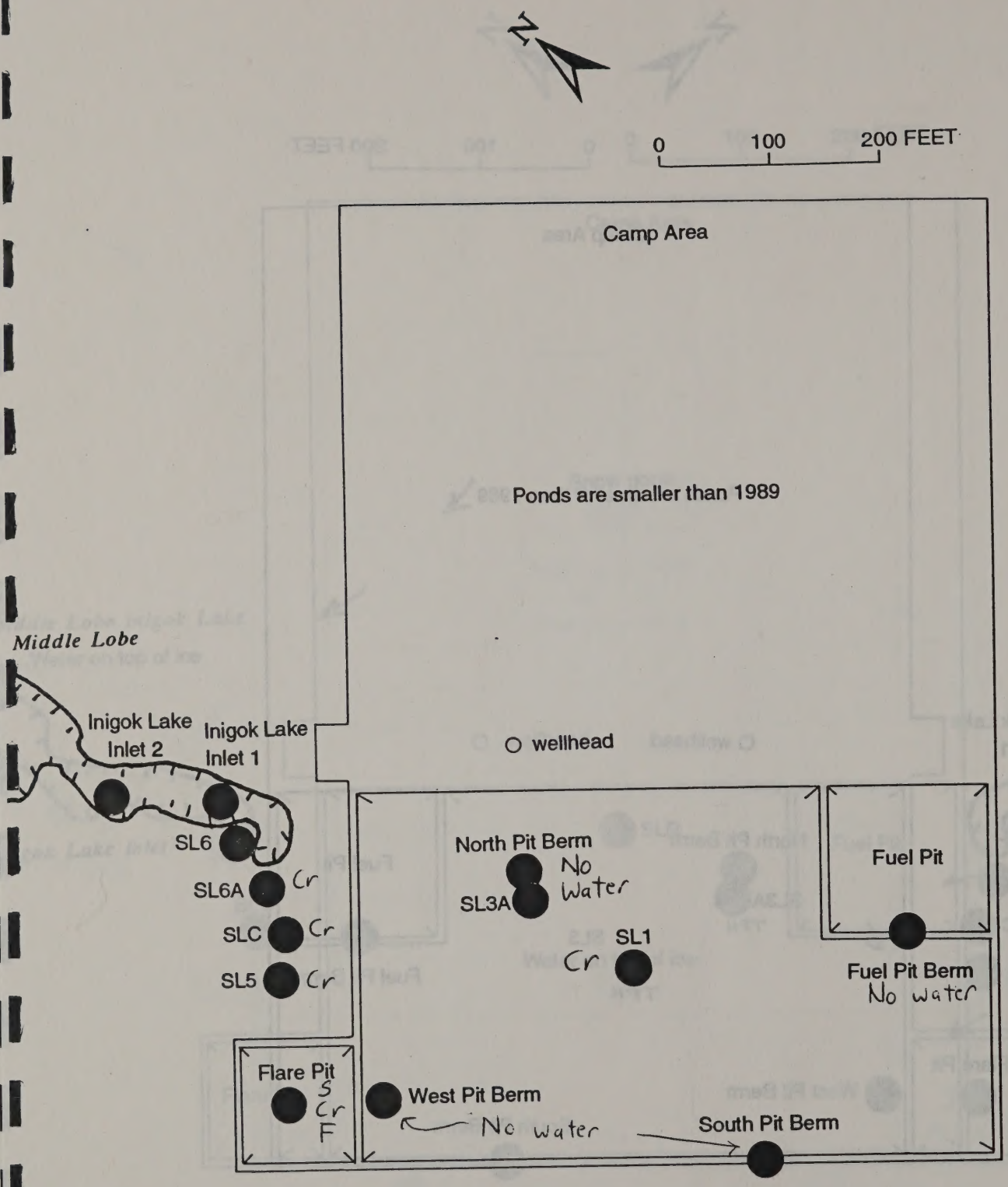
Locations of water samples and constituents having concentrations above criteria levels

Inigok, May 25, 1990



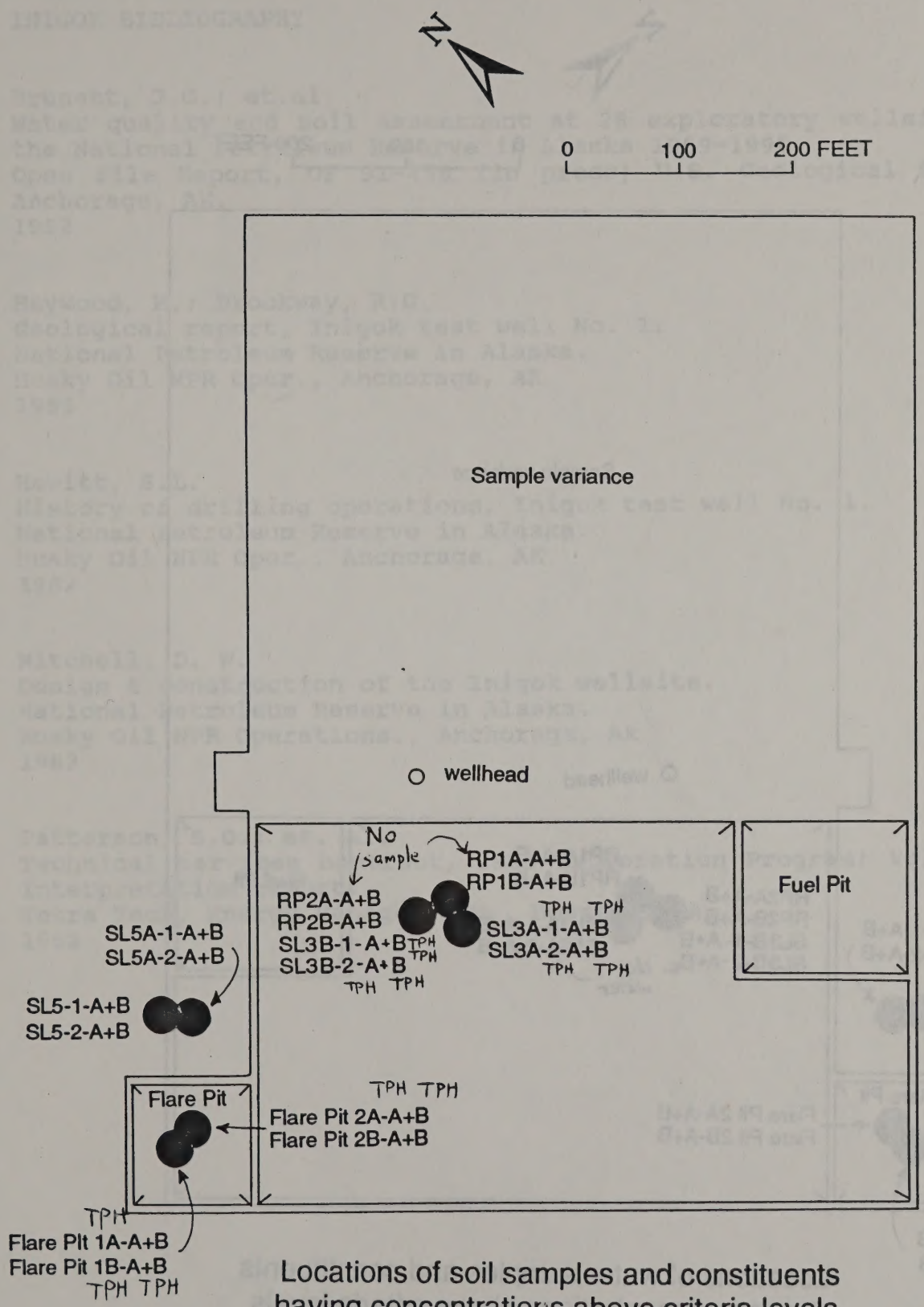
Inigok, July 30, 1990

Locations of soil samples and constituents having concentrations above criteria levels.



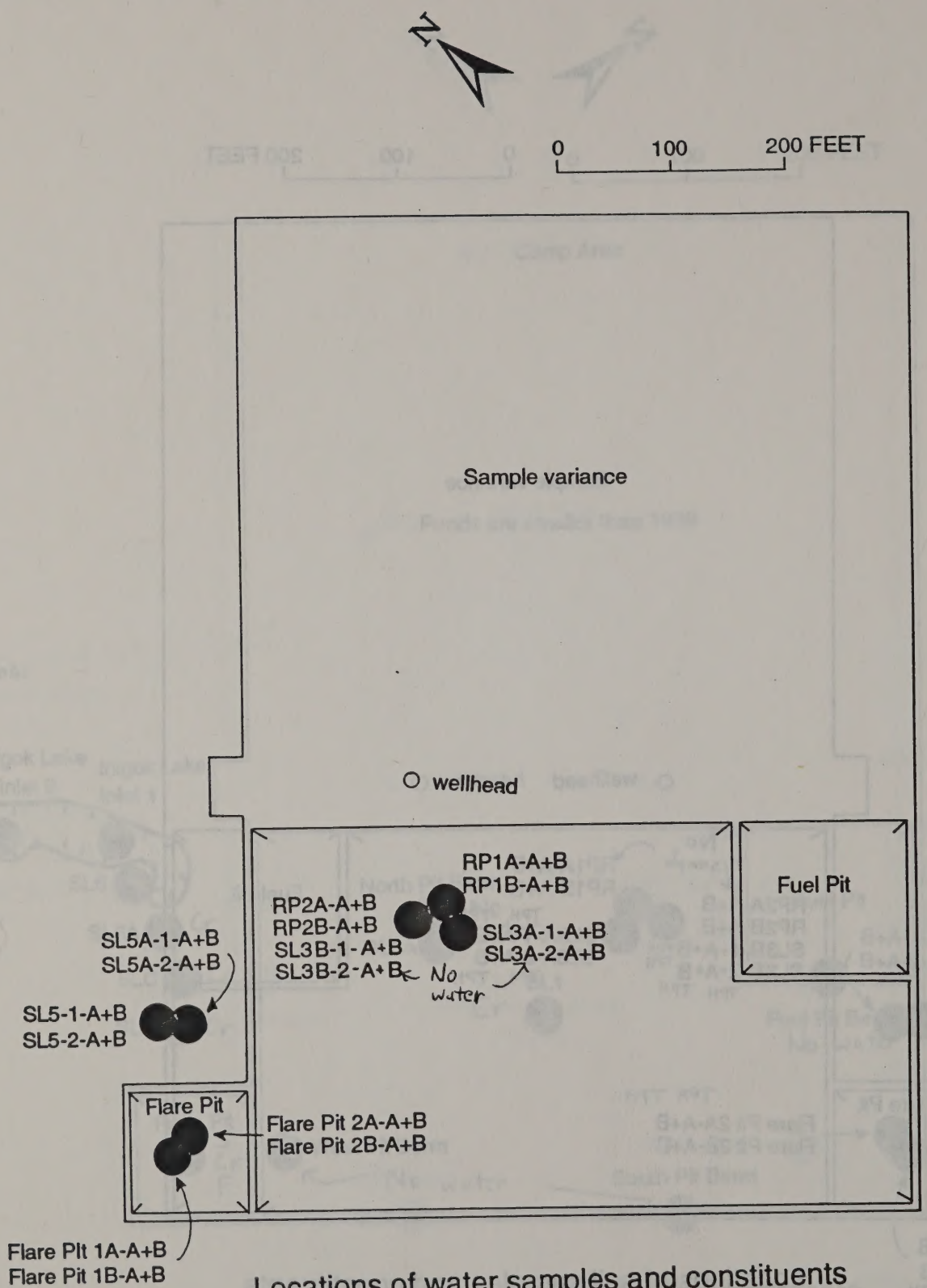
Locations of water samples and constituents having concentrations above criteria levels

Inigok, July 30, 1990



Locations of soil samples and constituents having concentrations above criteria levels.

Inigok, August 20-21, 1990



Locations of water samples and constituents having concentrations above criteria levels

Inigok, August 20-21, 1990

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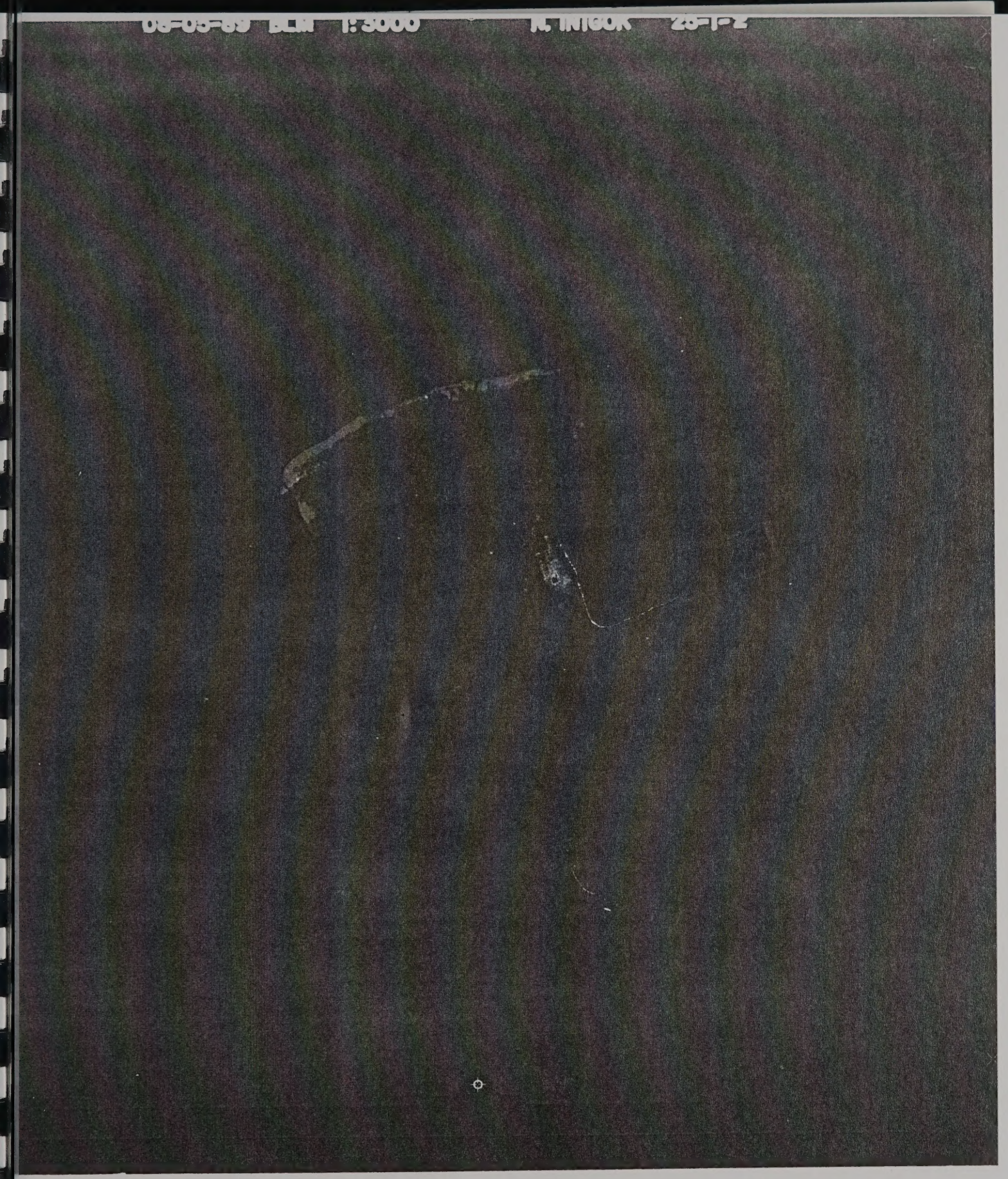
Locations of water samples and constituents having concentrations above criteria levels

Inigok, August 20-21, 1990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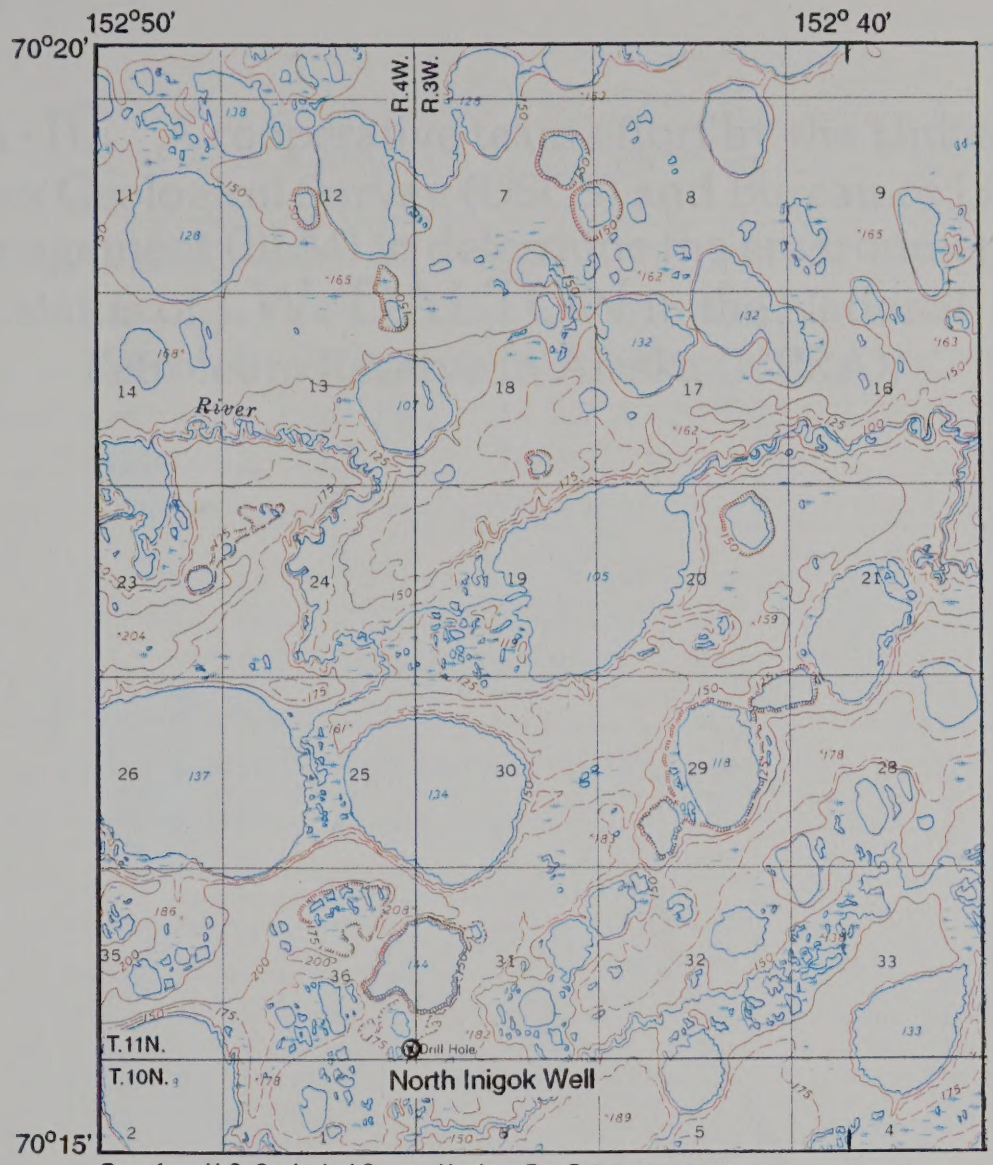


Base from U.S. Geological Survey, Harrison Bay B-5, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of North Inigok well.

A-10. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of J.W. DALTON in the National Petroleum Reserve in Alaska (NPRA).

10. WELLSITE RISK DETERMINATION

J.W. DALTON

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Seeded and/or Fertilized in 1980, 1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Pad and pit subsidence caused by melting underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Revegetation generally sparse because of gravel surface
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Drilling waste covered by 4 1/2 feet of water
Other Solids	None
Hydrocarbon Residue	None
Contaminant Level	see * below
Contaminant Migration	see * below
Contaminant Persistence	Site more than 13 years old. No contamination detected at site.
Risk Screening	
Risk to Fish & Wildlife	No basis for concern
Risk to Human Population	No basis for concern
RISK DETERMINATION	No basis for concern

* Chromium, Cobalt, Zinc and Barium were found to be elevated to elevated upgradient from the reserve pit site. The teams professional scientific judgment supported by NURE was that these elements are background and flowed into and out of the reserve pit along the gradient SL4-SL3-SL6. Barium is a constituent of drilling muds and is bound up with sediments.

J.W. Dalton

Location and Drilling Characteristics

Latitude: 70°55′13.79" *Longitude*: 153°08′15.10"

Location: T. 18 N., R. 5 W., Sec. 14 NW 1/4, Umiat Meridian

Depth: 9,367 ft *Drilled*: 5/7/79 - 8/1/79

Description

J.W. Dalton Test Well No. 1 (plate 11A) is 3.5 mi east of Lonely and about 85 mi southeast of Barrow. The site is located on high ground 0.3 mi east of the Smith River. The ground is about 16 ft above sea level. Drilling continued through the summer. No water-quality data were available prior to the 1989 sampling. The site was visited in 1989 but not in 1990.

Drilling Pad: The gravel material for the thick pad was taken from an area near a beach about 2 mi east of the wellsite. The site was seeded and fertilized in 1980 and 1982.

Reserve and Flare Pits: The reserve pit was not backfilled. Breaches occur on all sides of the berm except adjacent to the drilling pad. The flare pit was also not backfilled; it is open to the reserve pit and to the surrounding terrain.

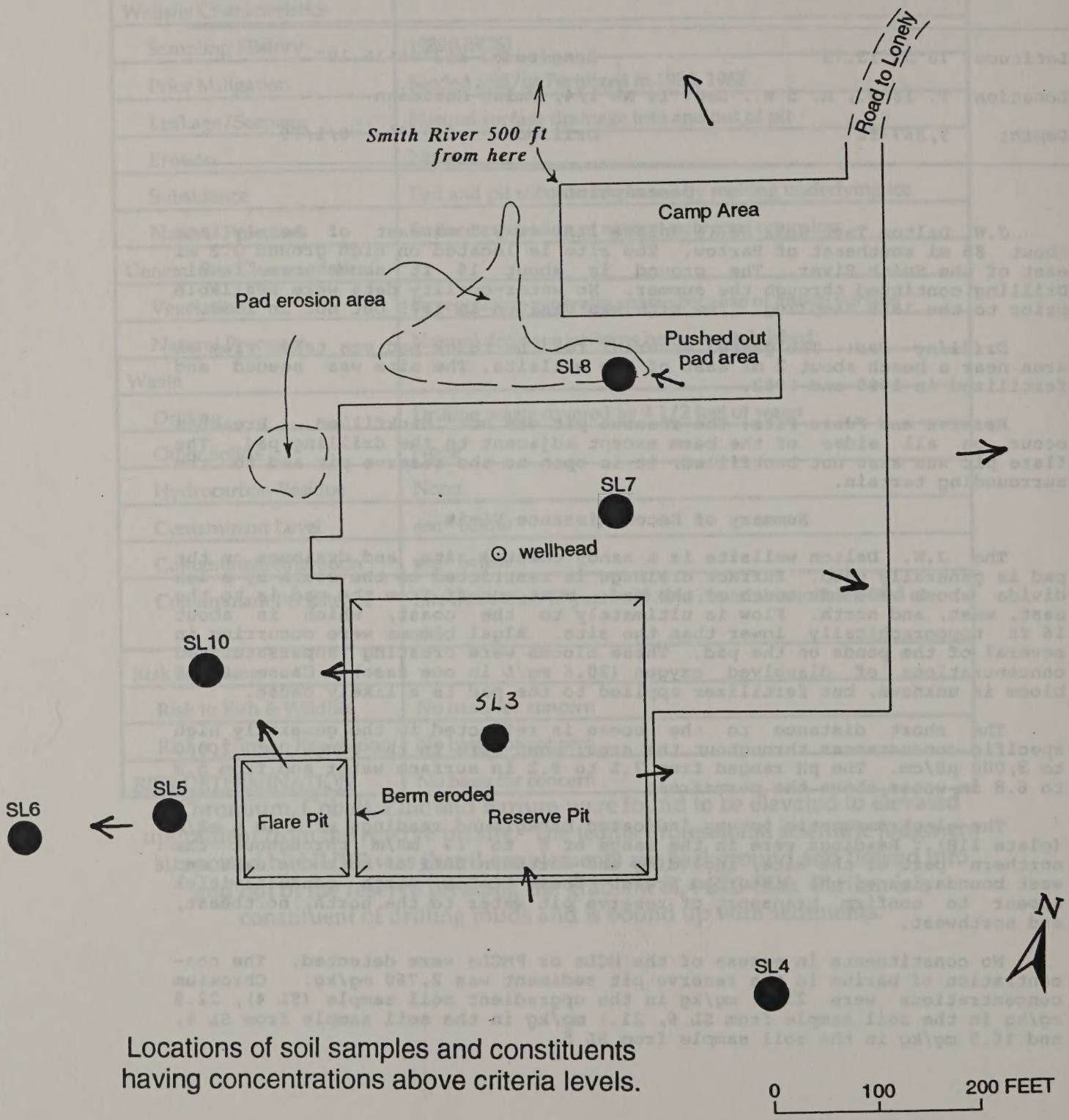
Summary of Reconnaissance Visit

The J.W. Dalton wellsite is a sandy coastal site, and drainage on the pad is generally good. Surface drainage is restricted to the south by a low divide about 100 ft south of the pad. Most runoff from the pad is to the east, west, and north. Flow is ultimately to the coast, which is about 16 ft topographically lower than the site. Algal blooms were occurring in several of the ponds on the pad. These blooms were creating supersaturated concentrations of dissolved oxygen (20.6 mg/L in one case). Cause of the bloom is unknown, but fertilizer applied to the pad is a likely cause.

The short distance to the ocean is reflected in the generally high specific conductances throughout the area; most were in the range of 2,000 to 3,000 µS/cm. The pH ranged from 7.1 to 9.2 in surface water and from 5.9 to 6.8 in water above the permafrost.

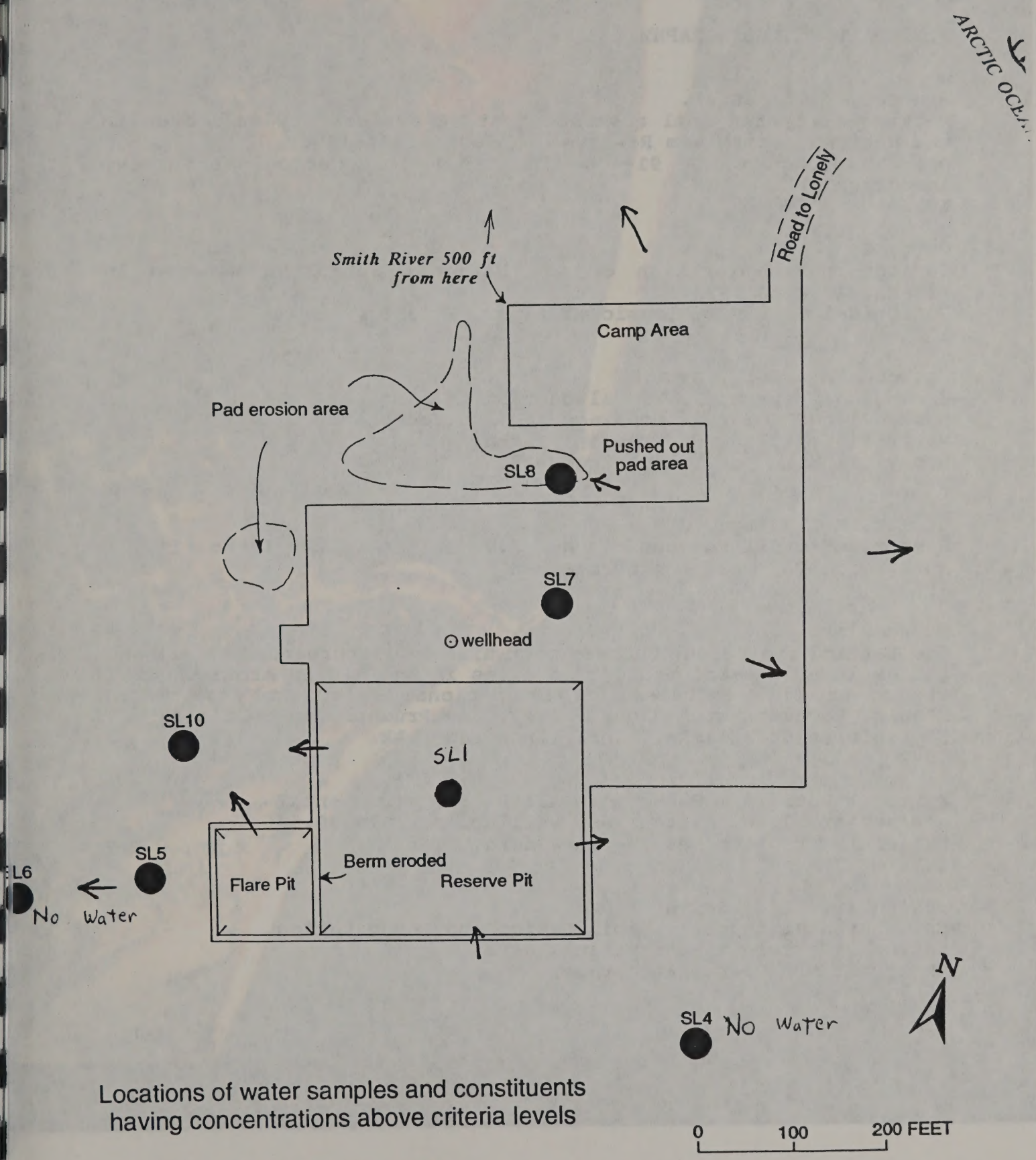
The electromagnetic survey indicated background readings of 4 to 6 mS/m (plate 11B). Readings were in the range of 8 to 17 mS/m throughout the northern part of the site, including the northern half of both the east and west boundaries of the disturbed areas. These higher earth conductivities appear to confirm transport of reserve pit water to the north, northeast, and northwest.

No constituents in excess of the MCLs or PMCLs were detected. The concentration of barium in the reserve pit sediment was 2,760 mg/kg. Chromium concentrations were 23.3 mg/kg in the upgradient soil sample (SL 4), 22.9 mg/kg in the soil sample from SL 6, 21.1 mg/kg in the soil sample from SL 8, and 16.5 mg/kg in the soil sample from SL 5.



Locations of soil samples and constituents having concentrations above criteria levels.

J.W. Dalton, 1989



Locations of water samples and constituents having concentrations above criteria levels

J.W. Dalton, 1989

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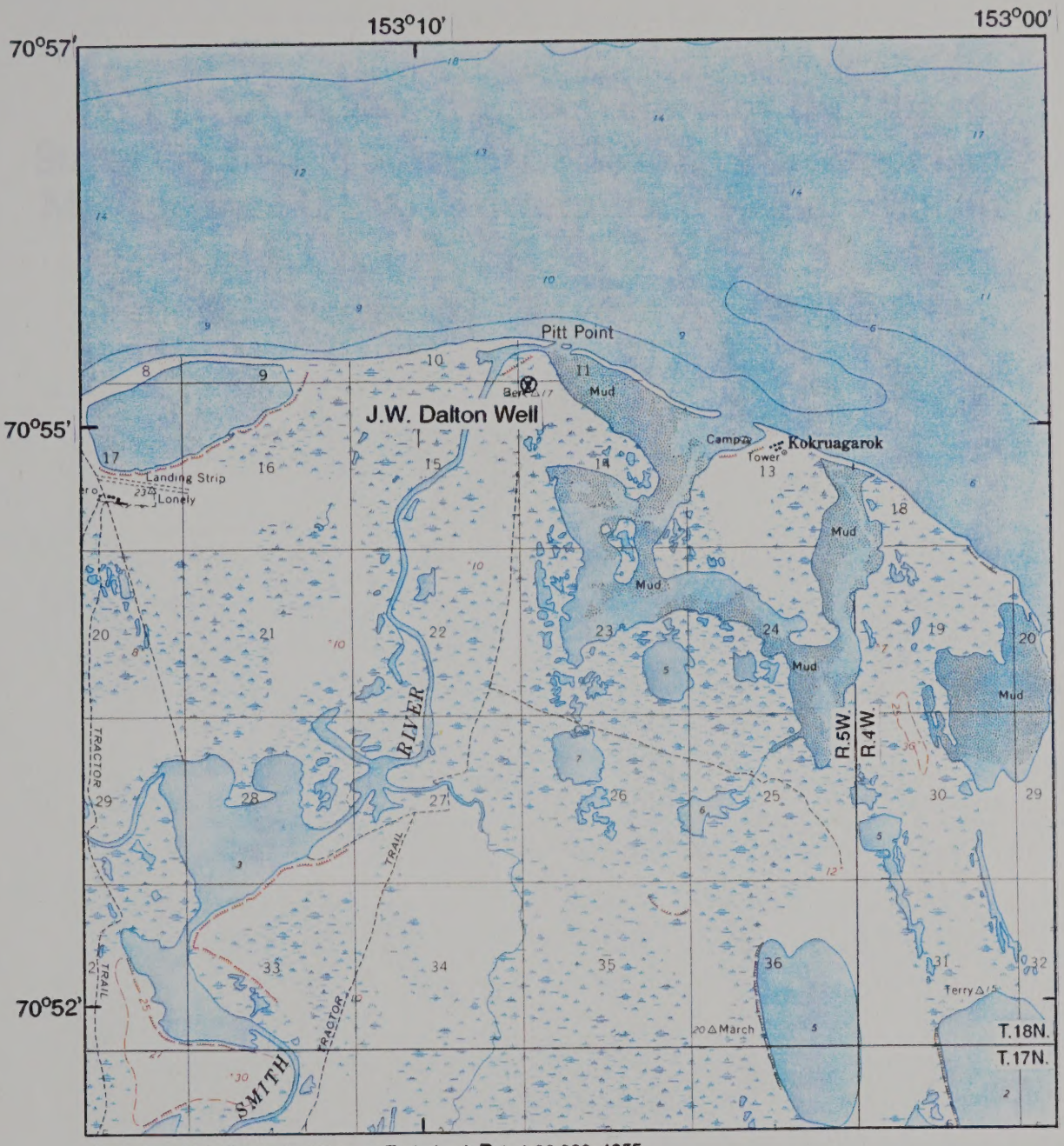
08-06-69
DALTON
2-2



Base from U.S. Geological Survey, Teshekpuk D-1, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of J.W. Dalton well.

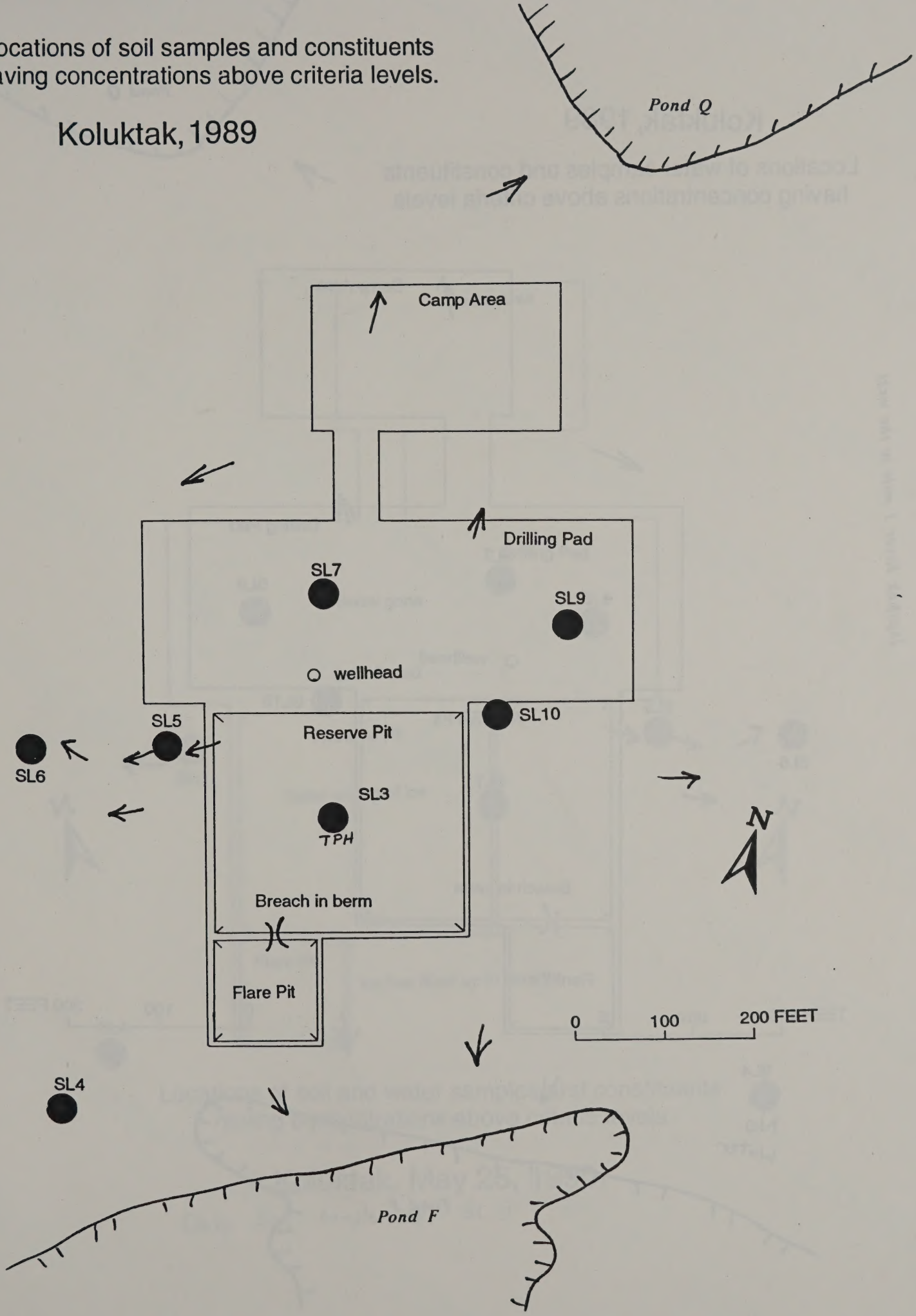
A-11. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of KOLUKTAK (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

11. WELLSITE RISK DETERMINATION
KOLUKTAK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989,1990(USGS)
Prior Mitigation	Seeded and/or Fertilized 1981
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Left uncovered, pit subsidence by melting of underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Good
Natural Processes	Drainage patterns being reestablished
Waste	
Drilling	Drilling waste covered by water up to 10 feet deep. TPH and BTEX elevated above background.
Other Solids	General trash
Hydrocarbon Residue	Elevated concentrations of TPH and BTEX measured, not mobile
Contaminant Level	Elevated levels of TPH and BTEX
Contaminant Migration	None observed
Contaminant Persistence	Associated with sediments. Site more than 11 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

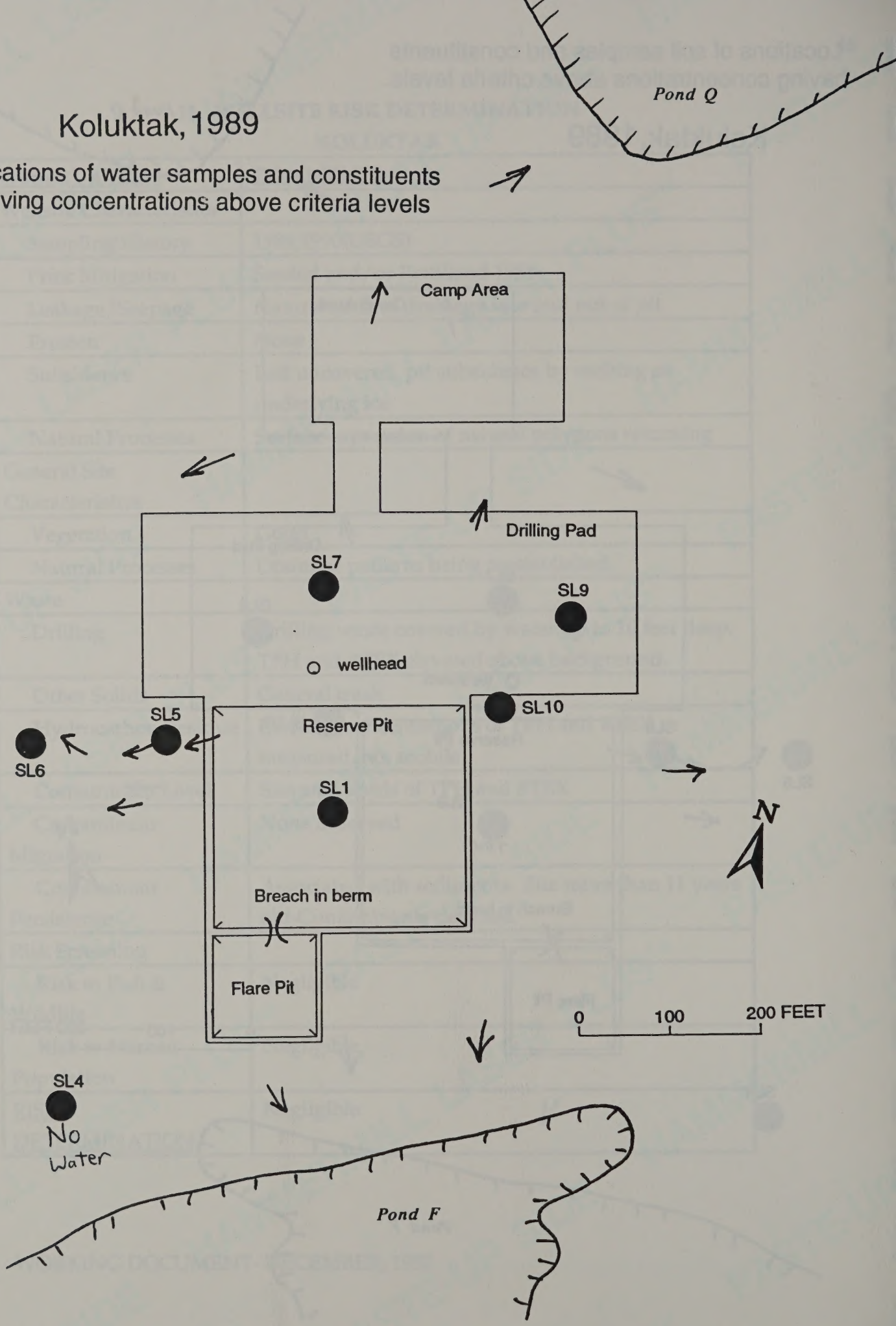
Locations of soil samples and constituents having concentrations above criteria levels.

Koluktak, 1989

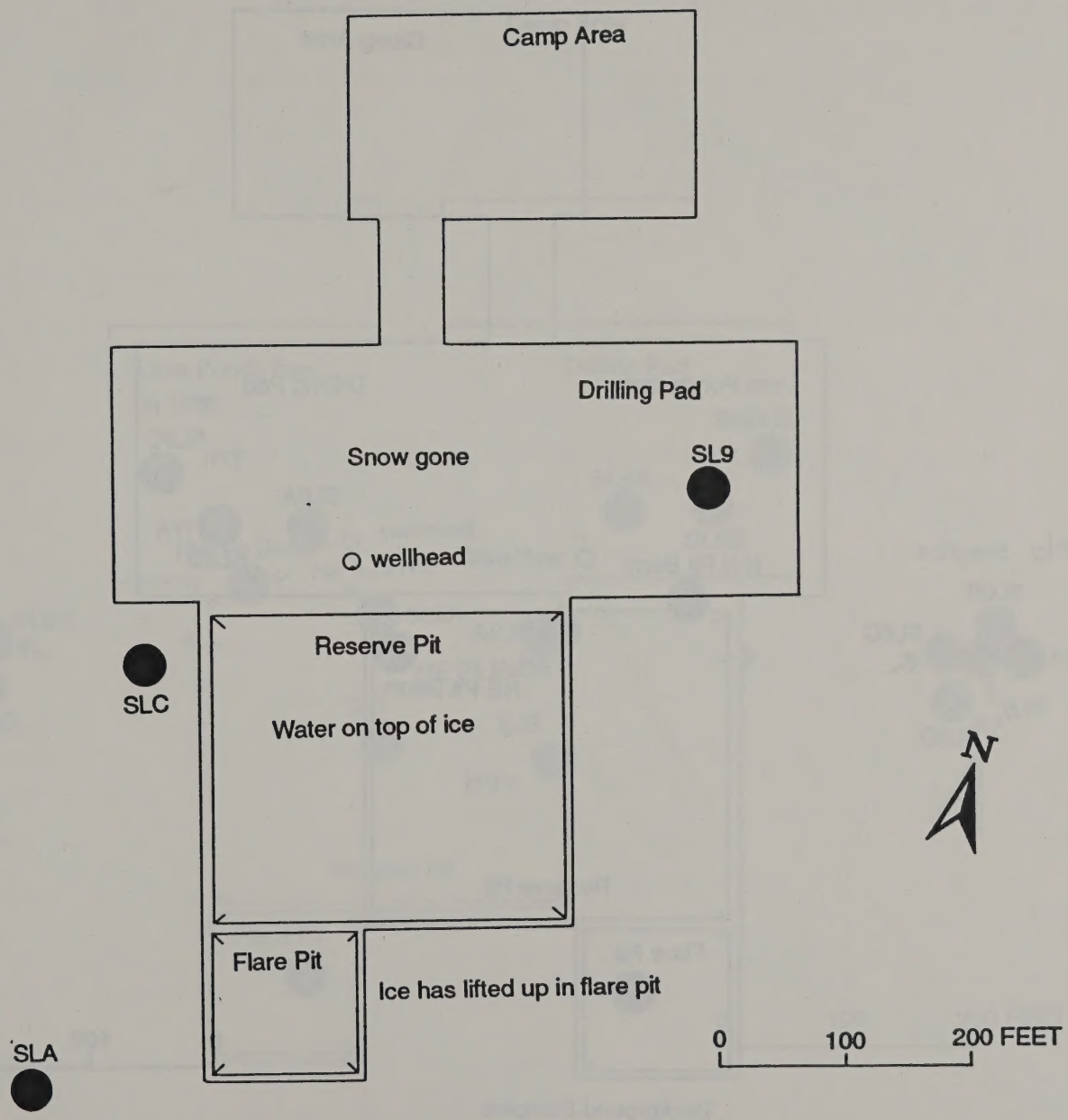


Koluktak, 1989

Locations of water samples and constituents having concentrations above criteria levels



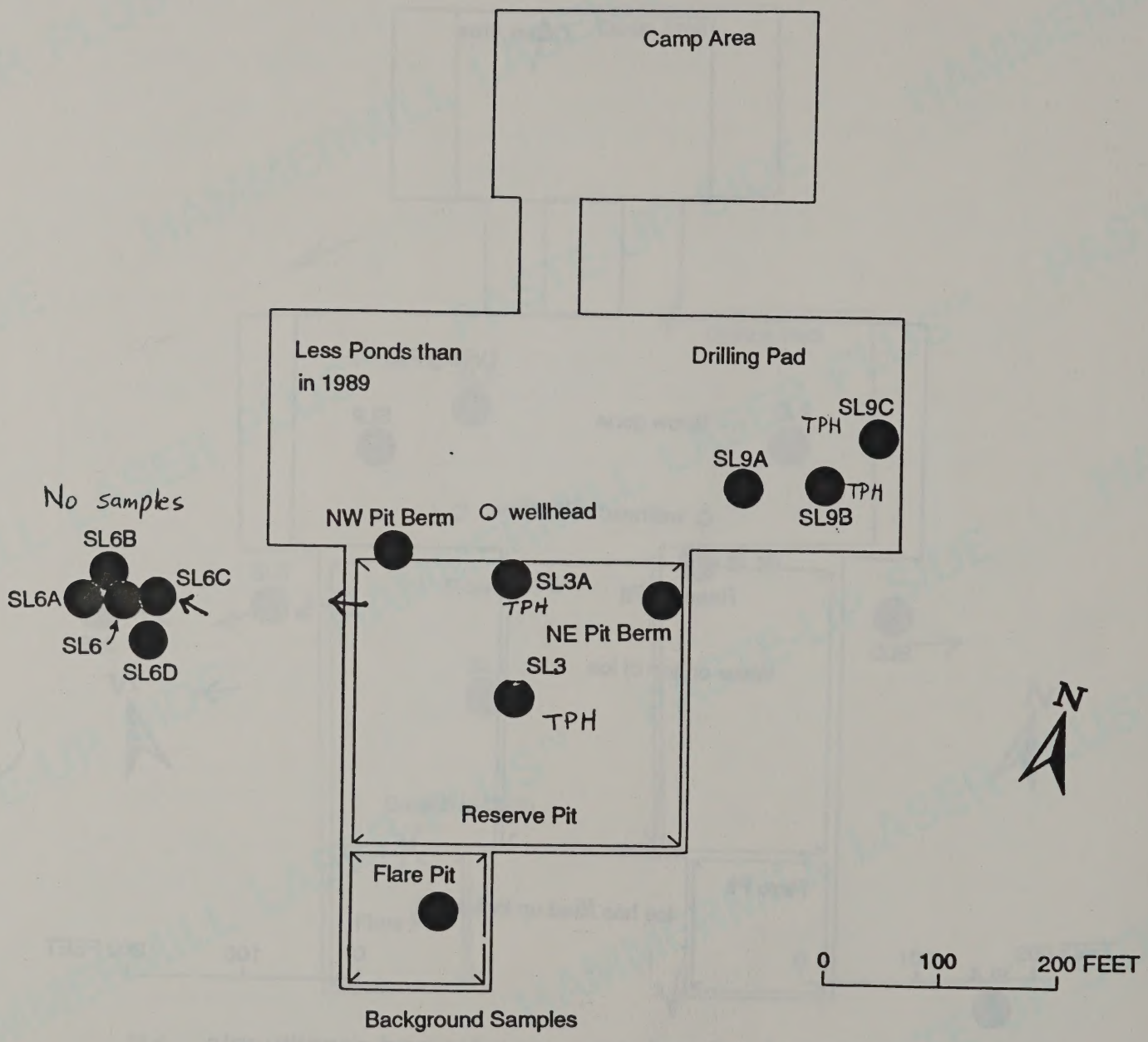
Ikpikuk River 1 mile to the west



Locations of soil and water samples and constituents having concentrations above criteria levels

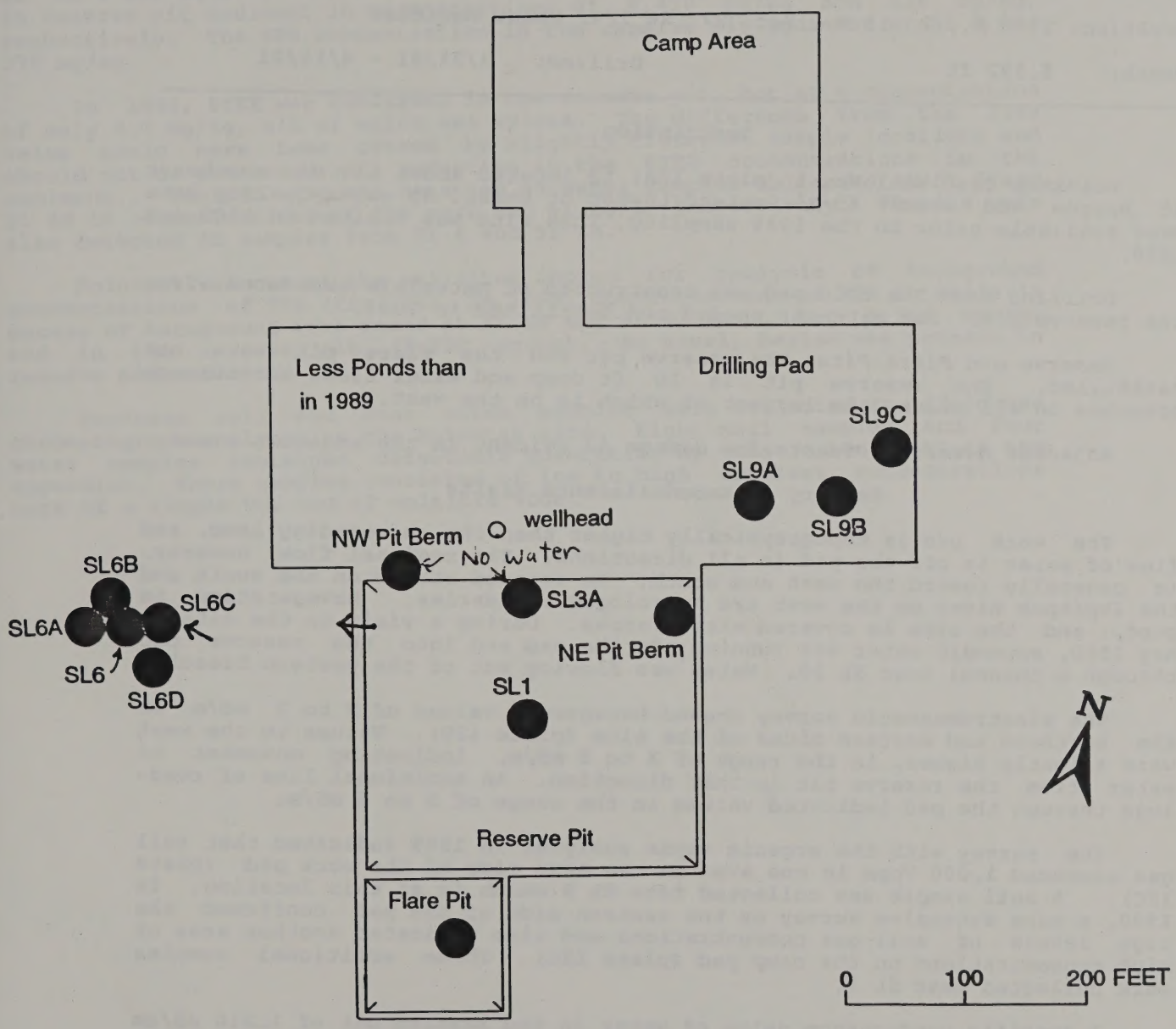
Koluktak, May 25, 1990

Only Soil sample at SL 9



Locations of soil samples and constituents having concentrations above criteria levels.

Koluktak, July 17, 1990



Locations of water samples and constituents having concentrations above criteria levels

Koluktak, July 17, 1990

Koluktak

Location and Drilling Characteristics

Latitude: 69°45'08.74" *Longitude*: 154°36'40.21"

Location: T. 5 N., R. 11 W., Sec. 27 SW 1/4, Umiat Meridian

Depth: 5,882 ft *Drilled*: 3/24/81 - 4/19/81

Description

Koluktak Test Well No. 1 (plate 12A) is located about 117 mi southeast of Barrow and about 65 mi west-northwest of Umiat. No water-quality data were available prior to the 1989 sampling. This site was visited in 1989 and 1990.

Drilling Pad: The thin pad was constructed of materials excavated from the reserve pit. The site was seeded and fertilized in 1981.

Reserve and Flare Pits: The reserve pit and the flare pit were not backfilled. The reserve pit is 10 ft deep and water flows out through breaches on all sides, the largest of which is on the west.

Adjacent Areas: No vegetation damage is evident in the adjacent areas.

Summary of Reconnaissance Visits

The work pad is topographically higher than the surrounding land, and flow of water is off the pad in all directions. The regional flow, however, is generally toward the west and south. An unnamed stream on the south and the Ikpikpuk River on the west are hydrologic boundaries. Revegetation is good, and the site is covered with grasses. During a visit to the site in May 1990, snowmelt water was running off the pad and into the reserve pit through a channel near SL 10. Water was flowing out of the western breach.

The electromagnetic survey showed background values of 2 to 3 mS/m on the northern and eastern sides of the site (plate 12B). Values to the west were slightly higher, in the range of 3 to 5 mS/m, indicating movement of water from the reserve pit in that direction. An additional line of readings through the pad indicated values in the range of 5 to 6 mS/m.

The survey with the organic vapor analyzer in 1989 indicated that soil gas exceeded 1,000 Vppm in one area on the east side of the work pad (plate 12C). A soil sample was collected from SL 9 which is at this location. In 1990, a more extensive survey on the eastern side of the pad confirmed the high levels of soil-gas concentrations and also indicated another area of high concentrations on the camp pad (plate 12E). Three additional samples were collected near SL 9.

A specific conductance value of water in the reserve pit of 1,510 µS/cm was measured in 1989. The specific conductance of water in the pit was 1,370 µS/cm in 1990 (plate 12D). Specific conductance of water in the outlying ponds and lakes is in the range of 50 to 100 µS/cm.

Ground-water samples were generally acidic, with pH in the range of 5.3 to 7.1 in both 1989 and 1990. Surface-water samples had pH in the range of 5.1 to 8.1.

In 1989, sediment in the reserve pit at SL 3 had a concentration of 22.9 mg/kg of BTEX, most of which was xylene. Barium concentration in water at SL 9 was equal to the MCL of 1.0 mg/L. Barium and chromium were present in reserve pit sediment in concentrations of 8,410 mg/kg and 128 mg/kg, respectively. The TPH concentration in the reserve pit sediment at SL 3 was 270 mg/kg.

In 1990, BTEX was confirmed in the reserve pit, but at a concentration of only 4.7 mg/kg, all of which was xylene. The difference from the 1989 value could have been caused by slightly different sample locations and should not be construed as a reduction in the BTEX concentrations in the sediment. Benzoic acid was detected in water samples collected at SL 6 and SL 6B in concentrations of 100 µg/L and 51 µg/L, respectively. Phenols were also detected in samples from SL 6 and SL 6A.

Koluktak was one of the wellsites chosen for analysis of background concentrations of TPH (fig. 11). In 1990, concentrations of TPH in soils in excess of background were found at SL 9B and SL 9C (both had 1,260 mg/kg) and in the reserve pit (1,250 mg/kg). As usual, barium was present in reserve pit sediment.

Fourteen soil and four water samples were collected for field gas chromatograph analyses at the Koluktak site. Eight soil samples and four water samples contained detectable quantities of VOCs (table 12-KO in the appendix). These samples consisted of low to high apparent concentrations both of a single VOC and of multiple VOCs.

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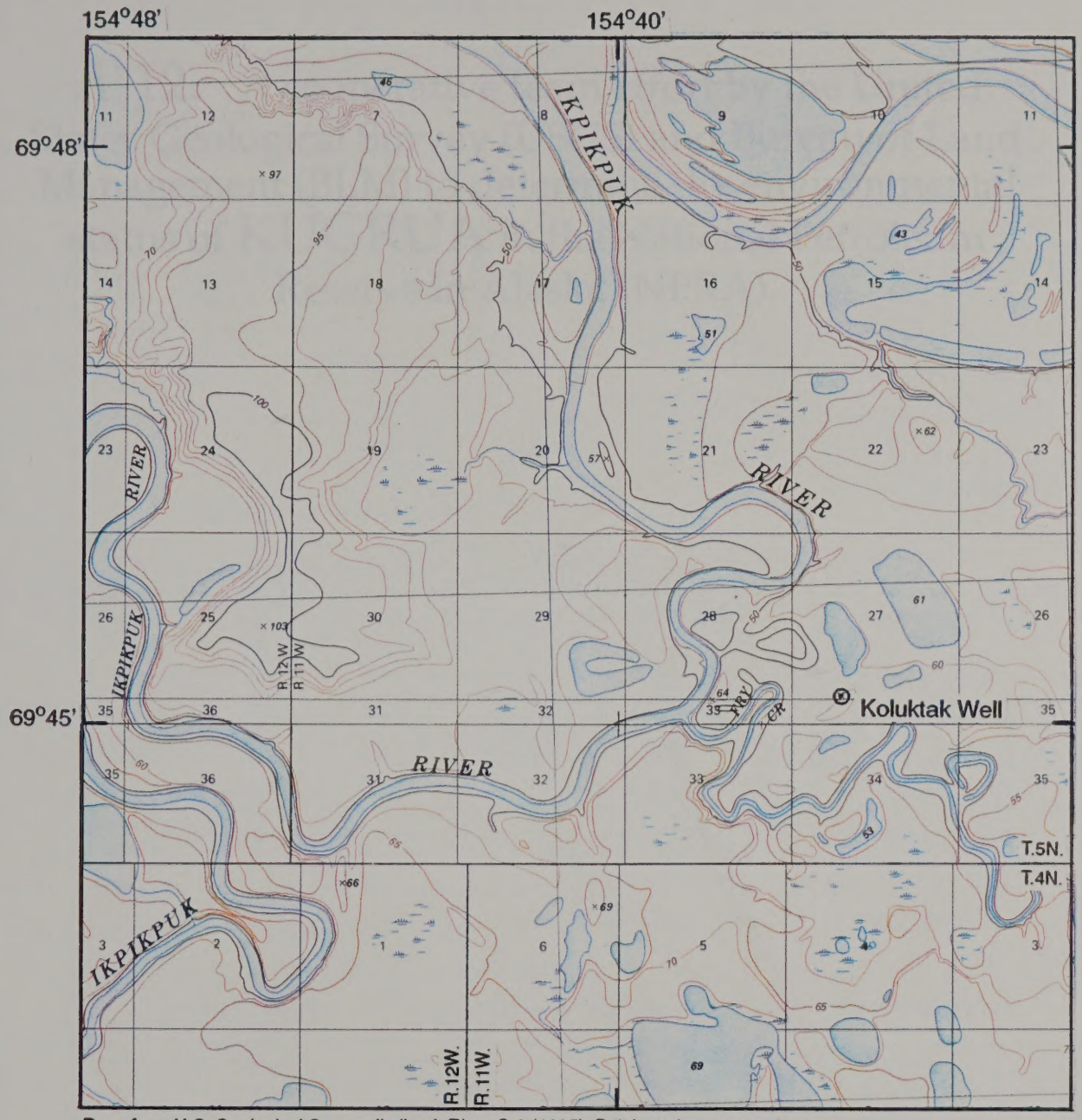
1983

08-07-89 BLM 1:3600 KOLUKTAK 28-3-1



Base from U.S. Geological Survey, Ikpikpuk River C-3 (1985), D-3 (1984), 1:63,360

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of Koluktak well.

A-12. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of KUGRUA in the National Petroleum Reserve in Alaska (NPRA).

12. WELLSITE RISK DETERMINATION
KUGRUA

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling history	1984(NUERA), 1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1979,1980 and 1982
Leakage/Seepage	Runoff from pad to pit, limited flow from pit in three directions
Erosion	None
Subsidence	Minimal
Natural Processes	Very slow return to natural conditions
General Site Characteristics	
Vegetation	Revegetation is sparse due to sandy surface
Natural Processes	Minimal due to thick pad, low relief and poor drainage
Waste	
Drilling	Drilling waste covered by up to 6 1/2 feet of water.
Other Solids	None observed
Hydrocarbon Residue	None observed
Contaminant Level	None
Contaminant Migration	None observed
Contaminant Persistence	Site more than 14 years old-No contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	No basis for concern
Risk to Human Population	No basis for concern
RISK DETERMINATION	No basis for concern

Kugrua

Location and Drilling Characteristics

Latitude: 70°35′13.28" *Longitude*: 158°39′43.26"

Location: T. 14 N., R. 26 W., Sec. 8 NW 1/4, Umiat Meridian

Depth: 12,588 ft *Drilled*: 2/12/78 - 5/29/78

Description

Kugrua Test Well No. 1 (plate 13A) is located about 64 mi southwest of Barrow in a drained lake basin. The terrain is relatively flat and water is present near the pad and reserve pit. Pad elevation is about 65 ft above sea level. Water-quality samples were collected by the Nuera Reclamation Company in July 1984. This site was visited in 1989 but not in 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/18/84	8.6-10.2 °C	8.5-8.7	490-498 µS/cm	Nuera Reclamation Company (1986, p. 38-39)

Drilling Pad: The drilling pad is thick. Pad and berms were constructed using materials, mostly sand, excavated from the reserve pit and a borrow site 1.5 mi southeast of the wellsite, along the Kugrua River. The site was seeded and (or) fertilized in 1979, 1980, 1981, and 1982.

Reserve and Flare Pits: The reserve pit and the flare pit are open, not backfilled. Water depth in the reserve pit was about 5.6 ft in July 1984. The berm is largely intact, but a breach on the eastern side and several low spots in the berm allow water out of the pit during runoff events.

Adjacent Areas: Low topographic relief has resulted in poor drainage.

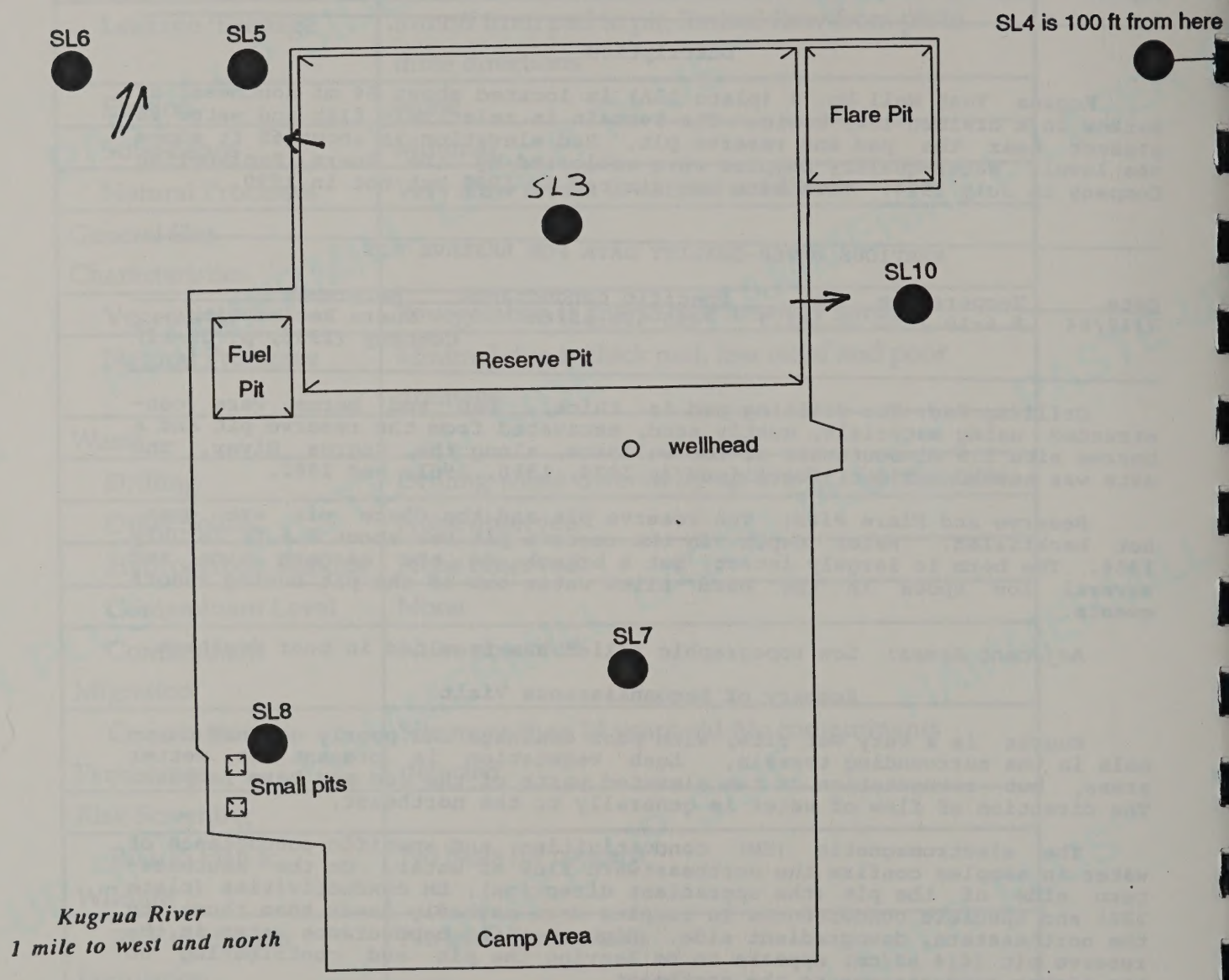
Summary of Reconnaissance Visit

Kugrua is a very wet site, with poor drainage and poorly defined channels in the surrounding terrain. Lush vegetation is present in wetter areas, but revegetation of the elevated parts of the pad and berm is poor. The direction of flow of water is generally to the northeast.

The electromagnetic (EM) conductivities and specific conductance of water in samples confirm the northeastward flow of water. On the southwestern side of the pit (the upgradient direction), EM conductivities (plate 13B) and specific conductances in samples were markedly lower than those on the northeastern, downgradient side. High specific conductance water in the reserve pit (614 µS/cm) appears to be leaving the pit and contributing to the higher conductances to the northeast.

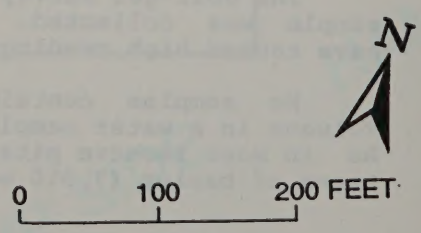
The soil-gas survey (plate 13C) indicated an anomaly at SL 8, where one sample was collected. The sample contained no significant VOCs that would have caused high readings.

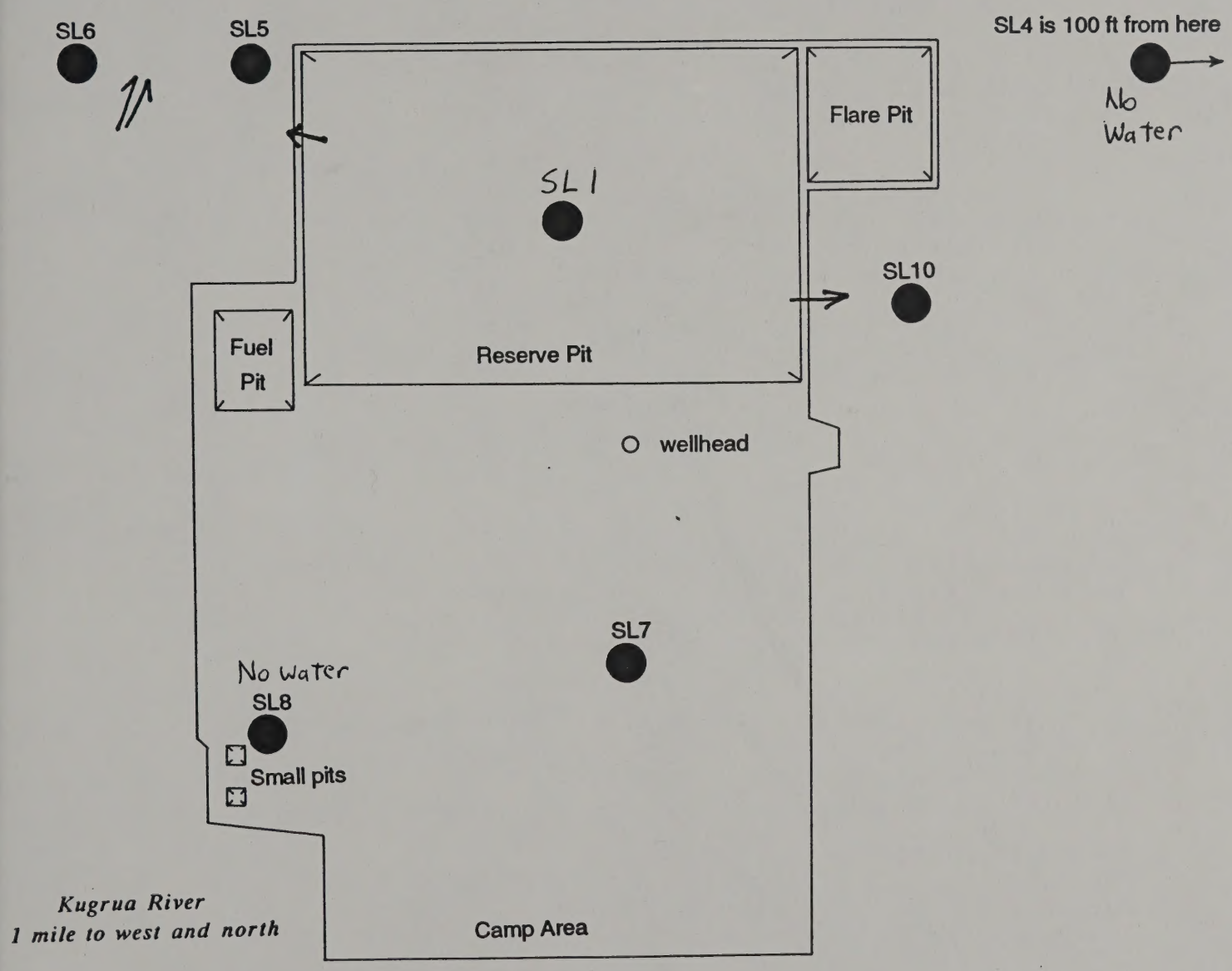
No samples contained concentrations that exceeded the MCLs or PMCLs. Toluene in a water sample at SL 10 (1.7 µg/L) was near the PMCL of 2 µg/L. As in most reserve pits, the sediment sample contained elevated concentrations of barium (7,910 mg/kg) and chromium (51 mg/kg).



Locations of soil samples and constituents having concentrations above criteria levels.

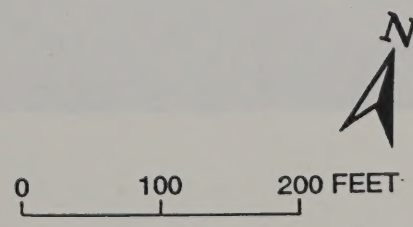
Kugrua, 1989





Locations of water samples and constituents having concentrations above criteria levels

Kugrua, 1989



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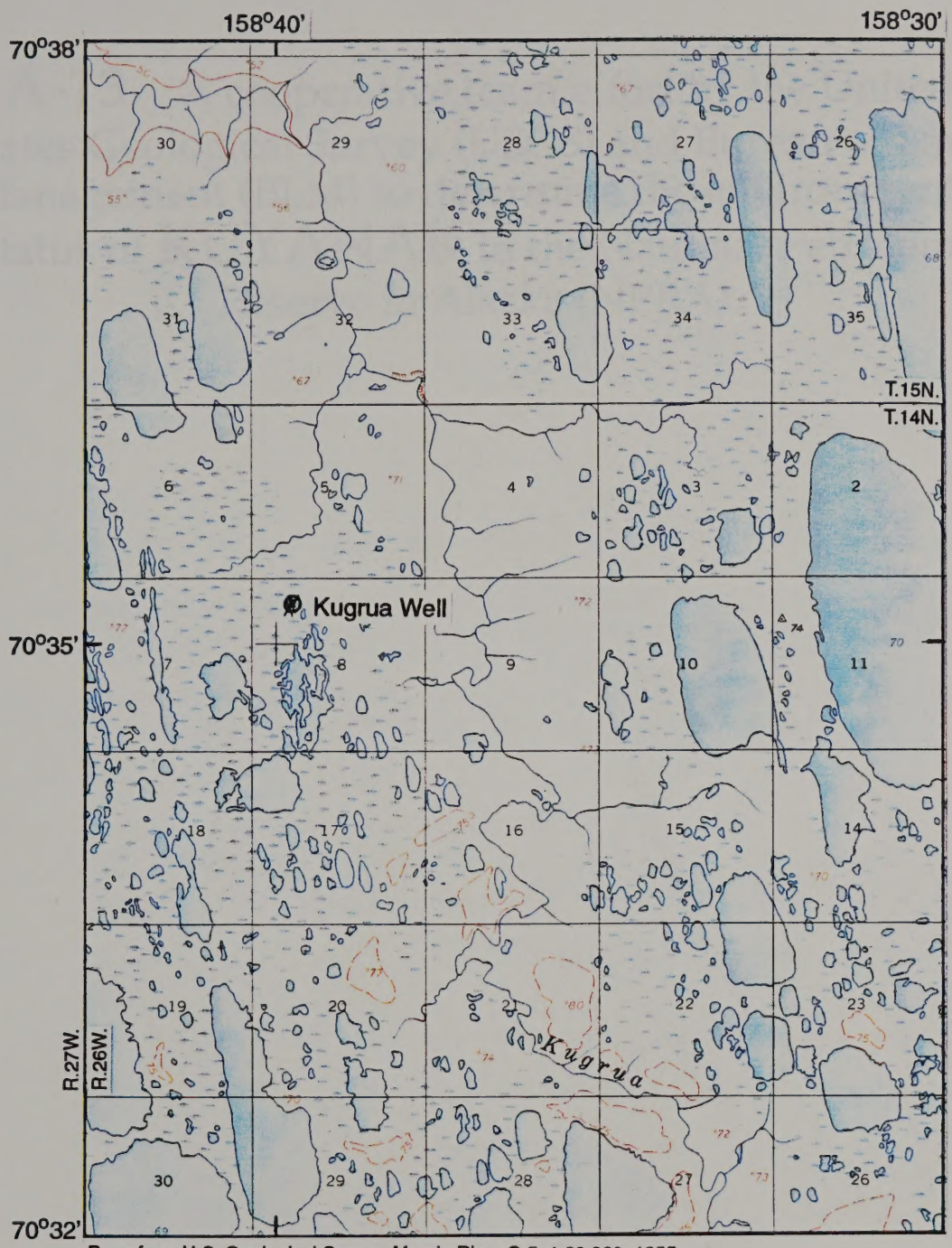
08-06-89 BLM 1:4000 KUGRUA 10-2-1



Location of Kugrua well.

A-13. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of KUYANAK in the National Petroleum Reserve in Alaska (NPRA).

13. WELLSITE RISK DETERMINATION
KUYANAK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1981(TETRA TECH), 1989 (USGS)
Prior Mitigation	Seeded and/or Fertilized 1981,1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Pad and pit subsided by melting underlying ice
Natural Processes	Very slow return to natural conditions
General Site Characteristics	
Vegetation	Silty soil placed on site contains natural salts which stress vegetation
Natural Processes	Normally slow in this area
Waste	
Drilling	Open pit, covered by water up to 7 1/2 feet deep in reserve pit
Other Solids	Exposed liner
Hydrocarbon Residue	TPH elevated on pad, TPH elevated in reserve pit
Contaminant Level	TPH elevated above background in soil on pad
Contaminant Migration	Retained in reserve pit
Contaminant Persistence	Associated with sediments. Site more than 11 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

Kuyanak

Location and Drilling Characteristics

Latitude: 70°55'53.48" *Longitude*: 156°03'58.08"

Location: T. 18 N., R. 16 W., Sec. 10 NW 1/4, Umiat Meridian

Depth: 6,690 ft *Drilled*: 2/18/81 - 3/31/81

Description

Kuyanak Test Well No. 1 (plate 14A) is in a drained lake basin about 1 mi north of Kuyanak Bay, an arm of Admiralty Bay, and is about 29 mi southeast of Barrow. Five tons of cement were disposed of in the reserve pit. Windborne cement may have damaged nearby vegetation west of the reserve pit. Water-quality samples for metals analysis were collected by Tetra Tech (1983) in February and March 1981. This site was visited in 1989 and in 1990.

Drilling Pad: Material for the thin pad and berms was from the excavation of the reserve pit and may have had high salinity. The site was seeded and (or) fertilized in 1981 and 1982.

Reserve and Flare Pits: The reserve pit is open, not backfilled. The berm around the reserve pit is fairly intact, but not high above the water surface. Breaches have formed on the southern and western sides and between the flare pit and reserve pit.

Summary of Reconnaissance Visits

Kuyanak is a very wet, poorly drained site, with a low gradient. Walking around the site in 1989 was difficult because of deep water and sticky mud. A low divide about 100 ft west of the pad delineates the eastern boundary of a large area of standing water. This standing water drains into a channel that flows south of the reserve pit into a large drainage feature southwest of the pad; flow is then to the southwest. Water is ponded against the pad and the reserve pit berm, especially on the north and west. Regional flow in the Kuyanak area is toward the southeast. Revegetation at the site is very poor.

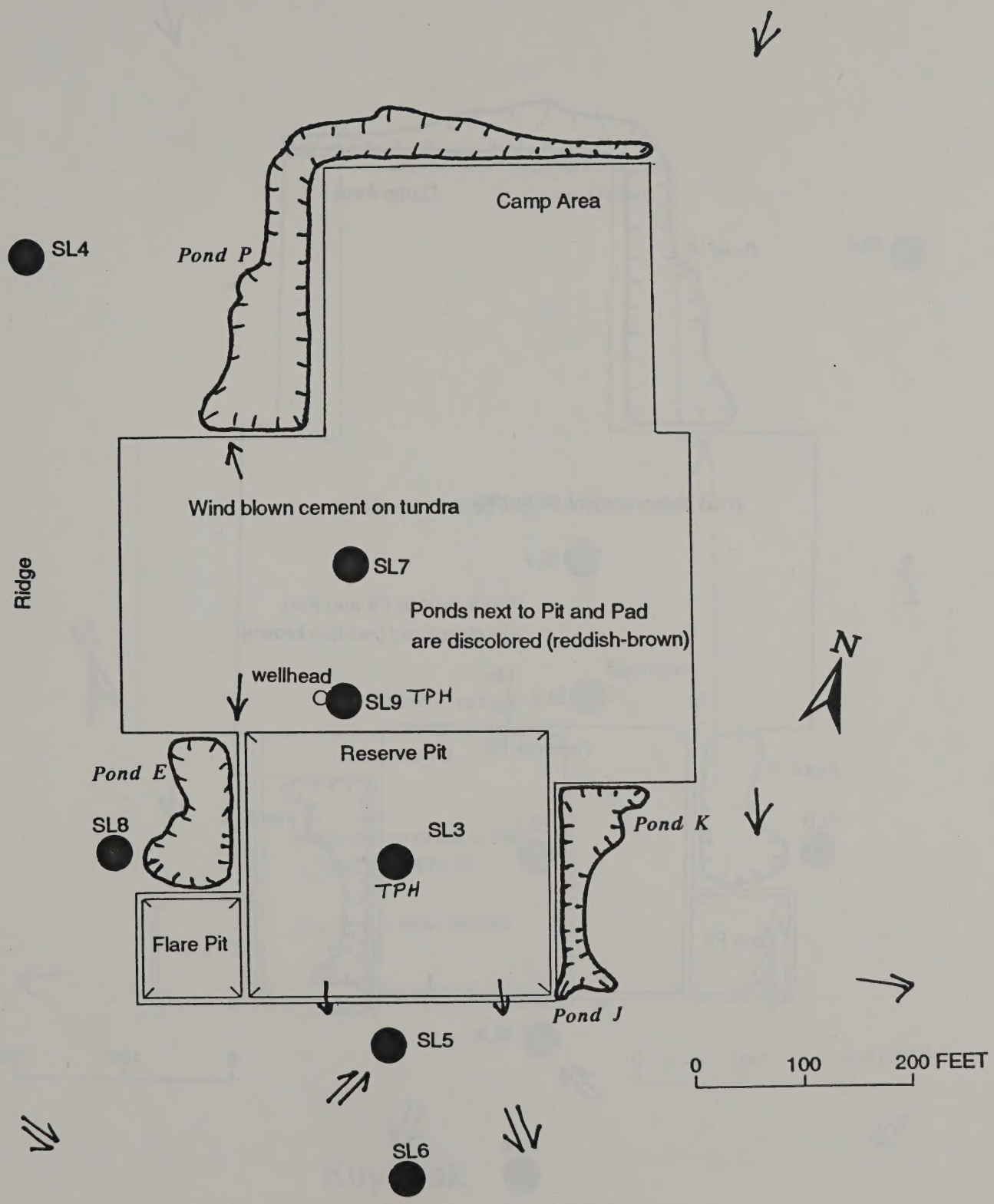
The electromagnetic survey showed generally high values, in the 20's and 30's of mS/m, throughout the area (plate 14B). Slight increases in earth conductivity to the 40's were detected near the flare pit and to the 50's downgradient from the southern side of the reserve pit. These slightly elevated earth conductivities probably relate to higher specific conductance of water from the reserve pit (7,680 µS/cm).

No trends could be discerned in the soil-gas survey, but a soil sample was collected at the wellhead (SL 9) where a high value of greater than 1,000 Vppm was recorded (plate 14C). The sample contained 1,200 mg/kg of TPH.

The pH of water on the pad and in the reserve pit was strongly alkaline, reflecting a large spill of cement during drilling. Ground-water samples were more acidic, with pH ranging from 5.9 to 6.7 in samples from SL 4, SL 5, SL 6, SL 7, and SL 8.

The concentrations of TPH in soil samples from SL 9 and the reserve pit sediment were 1,200 mg/kg and 410 mg/kg, respectively. BTEX concentration in reserve pit sediment was 2.5 mg/kg. A wide variety of semi-volatile compounds were detected in several samples. Both barium and chromium were detected in significant concentrations in soil samples collected in the reserve pit sediment and at the wellhead at SL 9.

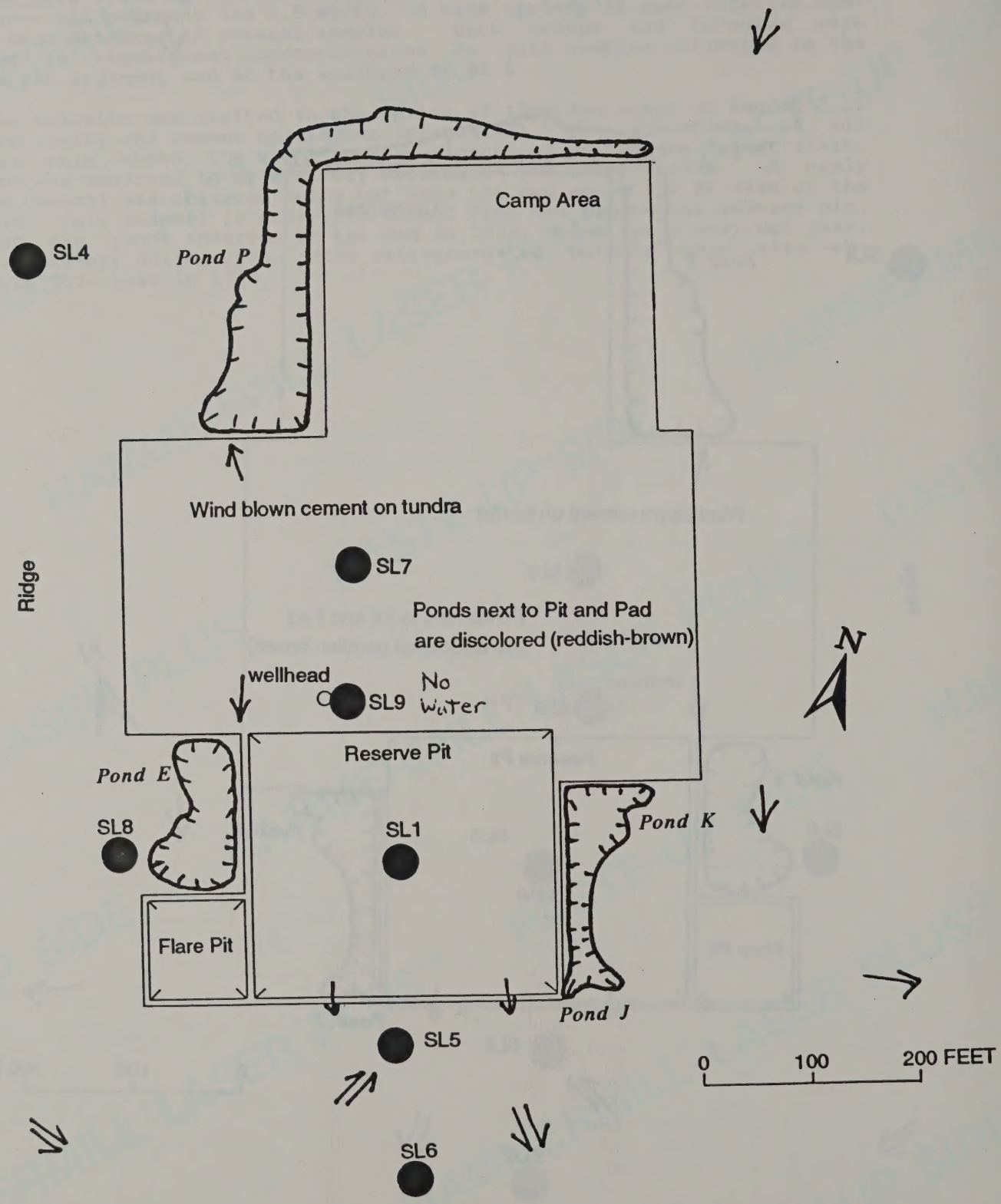
The wellsite was visited in the spring of 1990 and again on August 3 to evaluate spring and summer conditions (plate 14D). The elevations of all breaches were above the water-surface elevations during the August visit. The berm was observed to be actively eroding on the western side. A newly incised channel was observed being cut into the pad about 150 ft east of the wellhead. This channel is conveying runoff from the pad to the reserve pit. Many of the ponds observed on the pad in 1989, which was a very wet year, were not present during 1990. More salt-encrusted patches were also observed in 1990 than in 1989.



Kuyanak Bay 1 mile to the south

Kuyanak, 1989

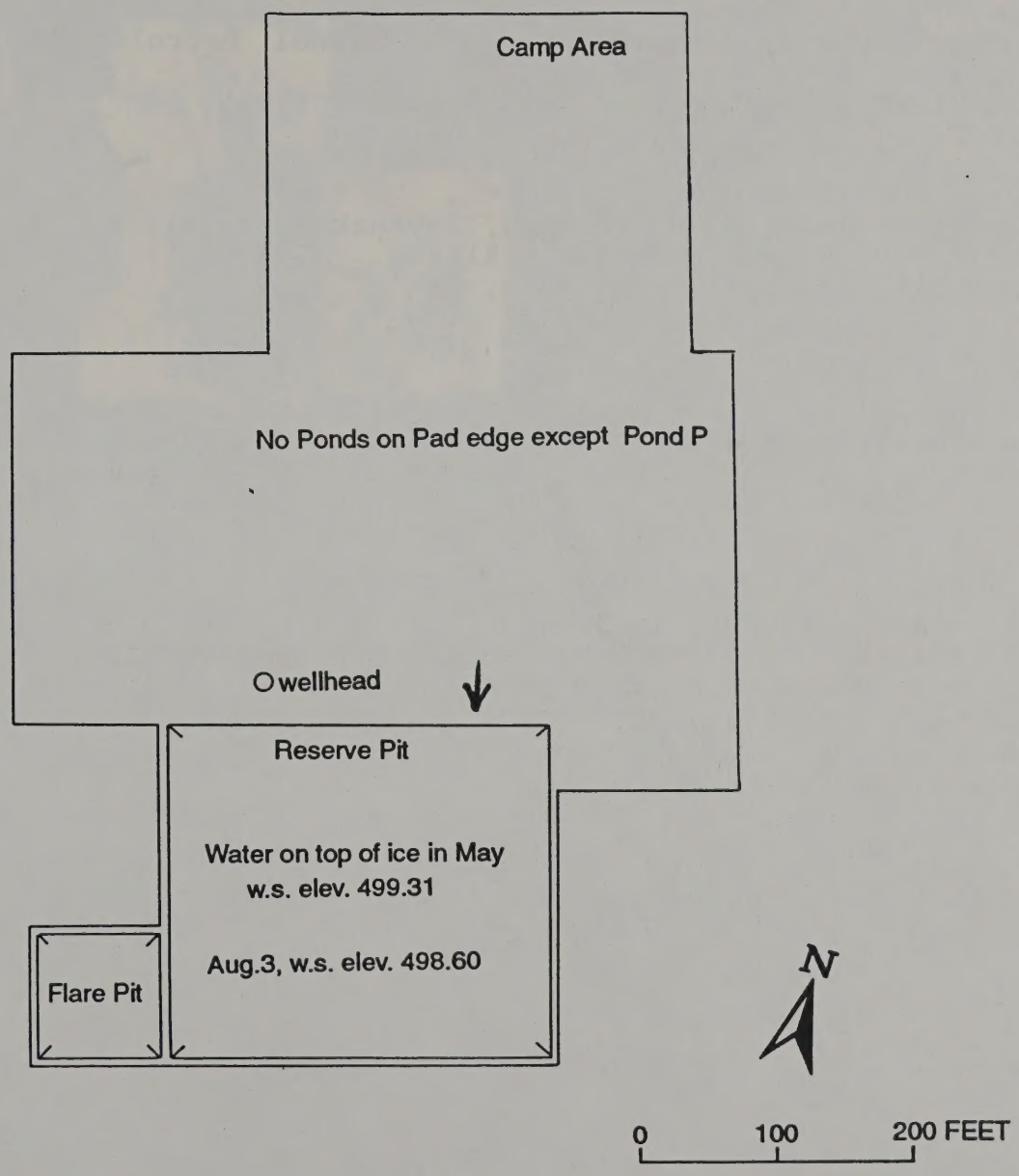
Locations of soil samples and constituents having concentrations above criteria levels.



Kuyanak Bay 1 mile to the south

Kuyanak, 1989

Locations of water samples and constituents having concentrations above criteria levels



Kuyanak
May 24 & August 3, 1990

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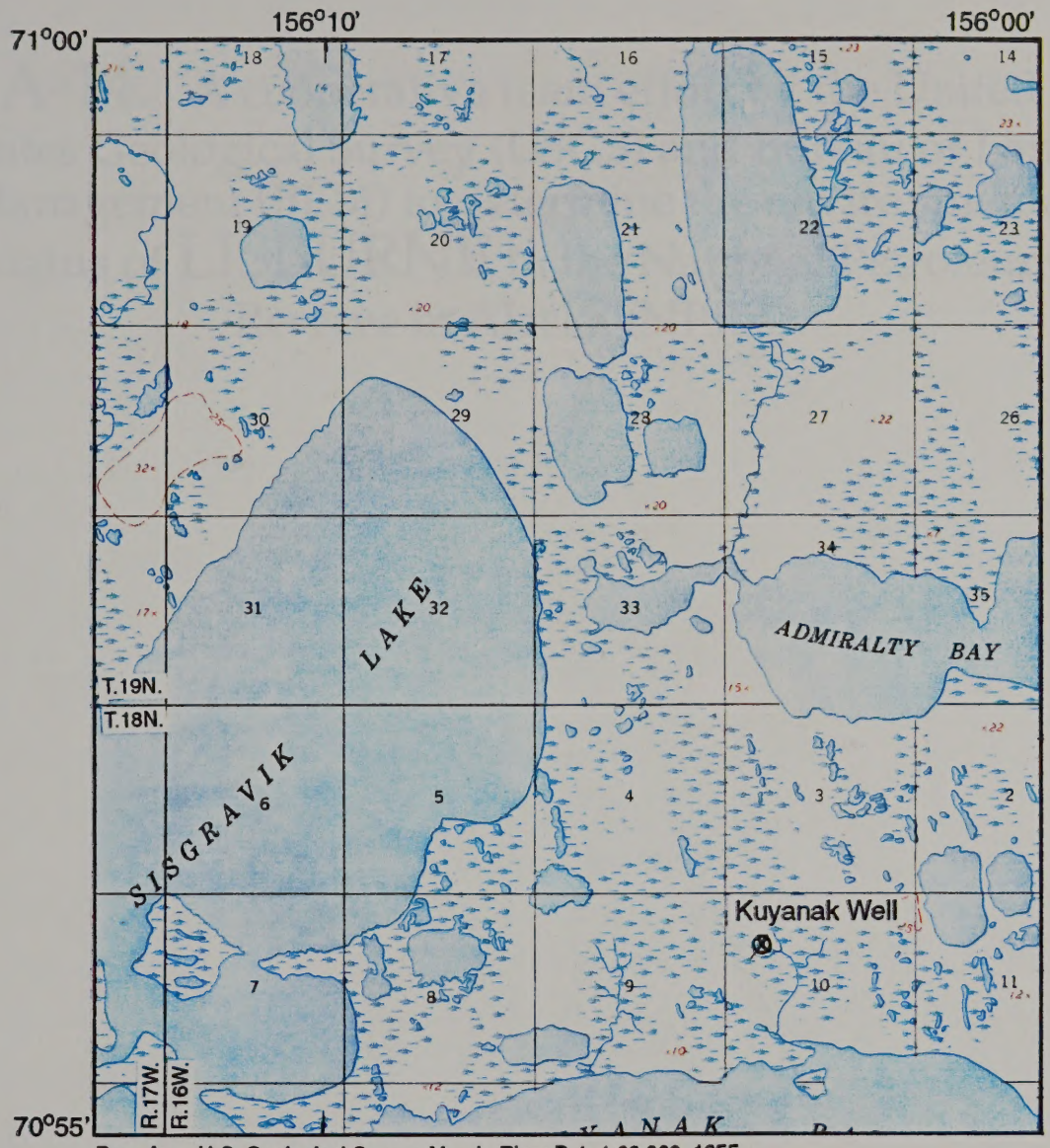


Base from U.S. Geological Survey, Meade River D-1, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of Kuyanak well.

A-14. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of LISBURNE in the National Petroleum Reserve in Alaska (NPRA).

14. WELLSITE RISK DETERMINATION
LISBURNE

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA), 1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1981,1982
Leakage/Seepage	Water seeps slowly through toe of massive berm
Erosion	None observed
Subsidence	None observed
Natural Processes	Natural drainage is being reestablished on upper camp pad
General Site Characteristics	
Vegetation	Sparse due to gravel and course materials on pad and berms
Natural Processes	Return to natural conditions was not planned in the design of the site
Waste	
Drilling	Elevated TPH in open reserve pit. Pit filled with up to 8 1/2 feet of water
Other Solids	None observed
Hydrocarbon Residue	None
Contaminant Level	Elevated TPH at reserve pit
Contaminant Migration	None
Contaminant Persistence	Associated with sediments. Site more than 12 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible. Periodic human visitation. Airfield is approximately 1.7 miles away
RISK DETERMINATION	Risk is negligible. Long term chance for failure of lower berm and transport of material-although heavy materials are below the level of permafrost and are expected to stay in or near pit and not reach a fish bearing stream about 1/2 mile away.

Lisburne

Location and Drilling Characteristics

Latitude: 68°29'05.44" *Longitude*: 155°41'35.51"

Location: T. 11 S., R. 16 W., Sec. 17 SE 1/4. Umiat Meridian

Depth: 17,000 ft *Drilled*: 6/11/79 - 8/23/79 and 10/24/79 - 6/2/80

Description

Lisburne Test Well No. 1 (plate 15A) is located on a north-facing hillside about 195 mi south-southeast of Barrow and 108 mi southwest of Umiat. The wellsite is in an east-west trending valley between parallel ridges of the Ivotuk Hills. A thick tundra mat covers the valley floor and a small intermittent stream flows along the northern edge of the wellsite. There is a 52-foot difference in elevation between the highest part of the pad (1,851 ft above sea level) and the bottom of the reserve pit (1,799 ft). A 1.7-mile road connects the wellsite to a gravel airstrip. The site was seeded and fertilized in 1981 and 1982. Water-quality samples were collected by the Nuera Reclamation Company in July 1984. The site was visited in 1989 but not in 1990.

The water-quality data presented below represent the range of values determined in water-depth profiles at two sites in the reserve pit.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/17/84	13.2-15.8 °C	8.4-8.6	490-610 µS/cm	Nuera Reclamation Company (1986, p. 124)

Drilling Pad: A thick pad with insulation was used. The pad and berms were constructed using material excavated from the reserve pit and from terraces along Otuk and Ivotuk Creeks. The drilling pad was left intact after well completion.

Reserve and Flare Pits: The reserve and flare pits are open, not backfilled. Runoff from areas upgradient from the wellsite collects along the pad and flows downgradient along the side of the pad and the reserve pit. Berms are stable and in good condition. Water depth in the pit ranged from 6 to 7 ft in July 1984, and was 8.5 ft in August 1989.

Adjacent Areas: No vegetation damage noted.

Summary of Reconnaissance Visit

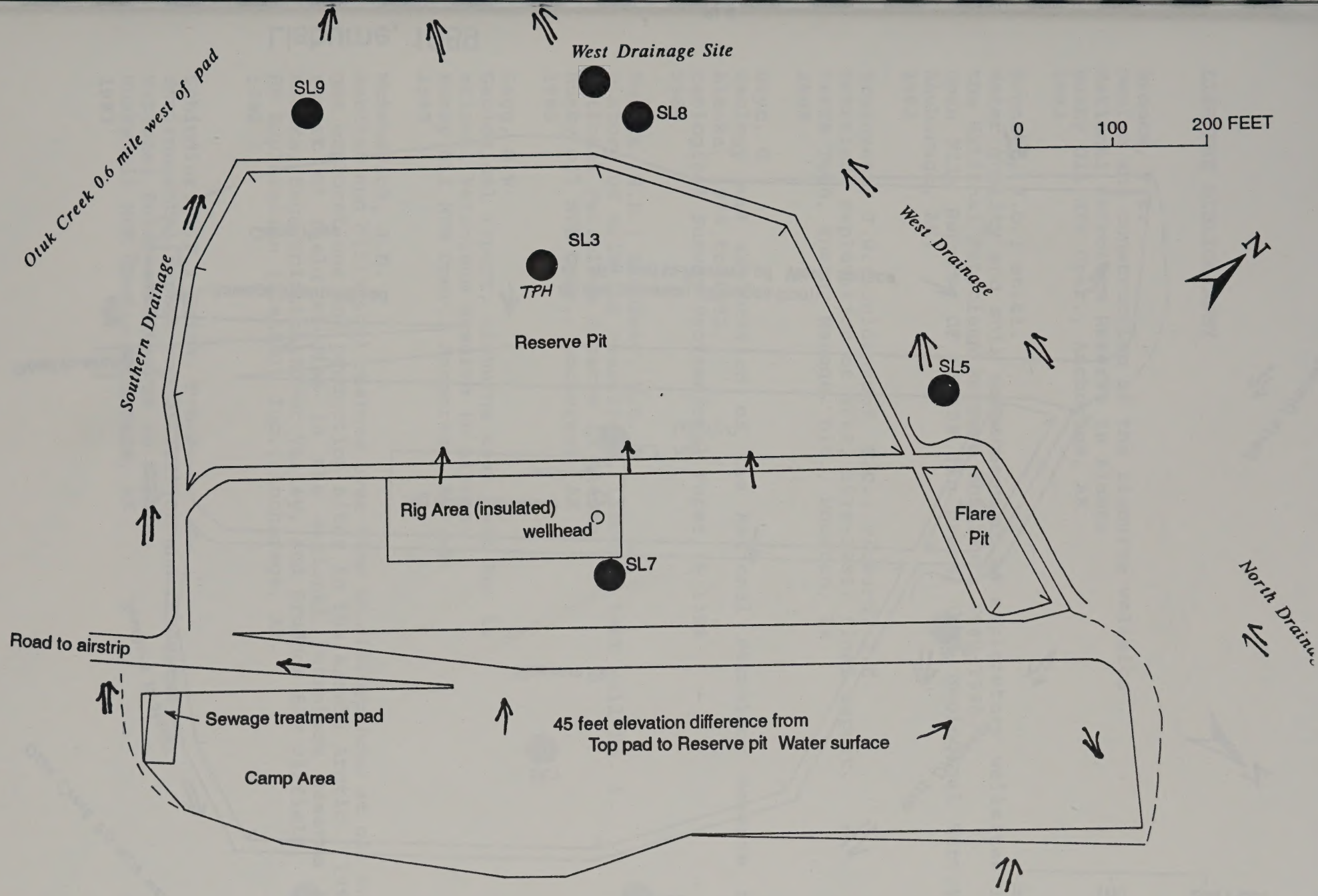
The drilling pad and berms at the Lisburne wellsite were constructed with coarse-grained materials that resist erosion. The coarse-grained berms are intact, but not impermeable. Water seeps slowly through the berms and discharges along the toe of the berm. The coarse materials of the pad and berms do not support vegetation.

Background specific conductances of water in areas adjacent to the wellsite generally range from 220 to 256 µS/cm. The specific conductance of water in Pond J near the seeps at the toe of the berm is 481 µS/cm; it is similar to the specific conductance of water in the reserve pit, 488 µS/cm. Specific conductance of water is elevated at SL 8 and SL 9 downgradient from the reserve pit.

A soil-gas survey was not done. The soils were too rocky to penetrate with the stainless-steel probe. The electromagnetic survey (plate 15B) indicated slightly elevated measurements of earth conductivity in areas downgradient from the wellsite. Earth conductivity measurements ranged from 5 to 8 mS/m in downgradient areas and from 3 to 4 mS/m in upgradient areas.

A sediment sample collected in the reserve pit had a TPH concentration of 830 mg/kg. None of the water samples collected at the wellsite had constituents in concentrations that exceeded MCLs or PMCLs. An elevated concentration of toluene was detected in a water sample collected at SL 5. Significant concentrations of barium and chromium were detected in sediment samples collected in the bottom of the reserve pit and the drilling pad; thallium was also detected here.

None of the elements that are regulated by the USEPA (1986b) for the protection of fish and wildlife exceeded the maximum allowable concentration limit in the sample from the west drain around the wellsite.

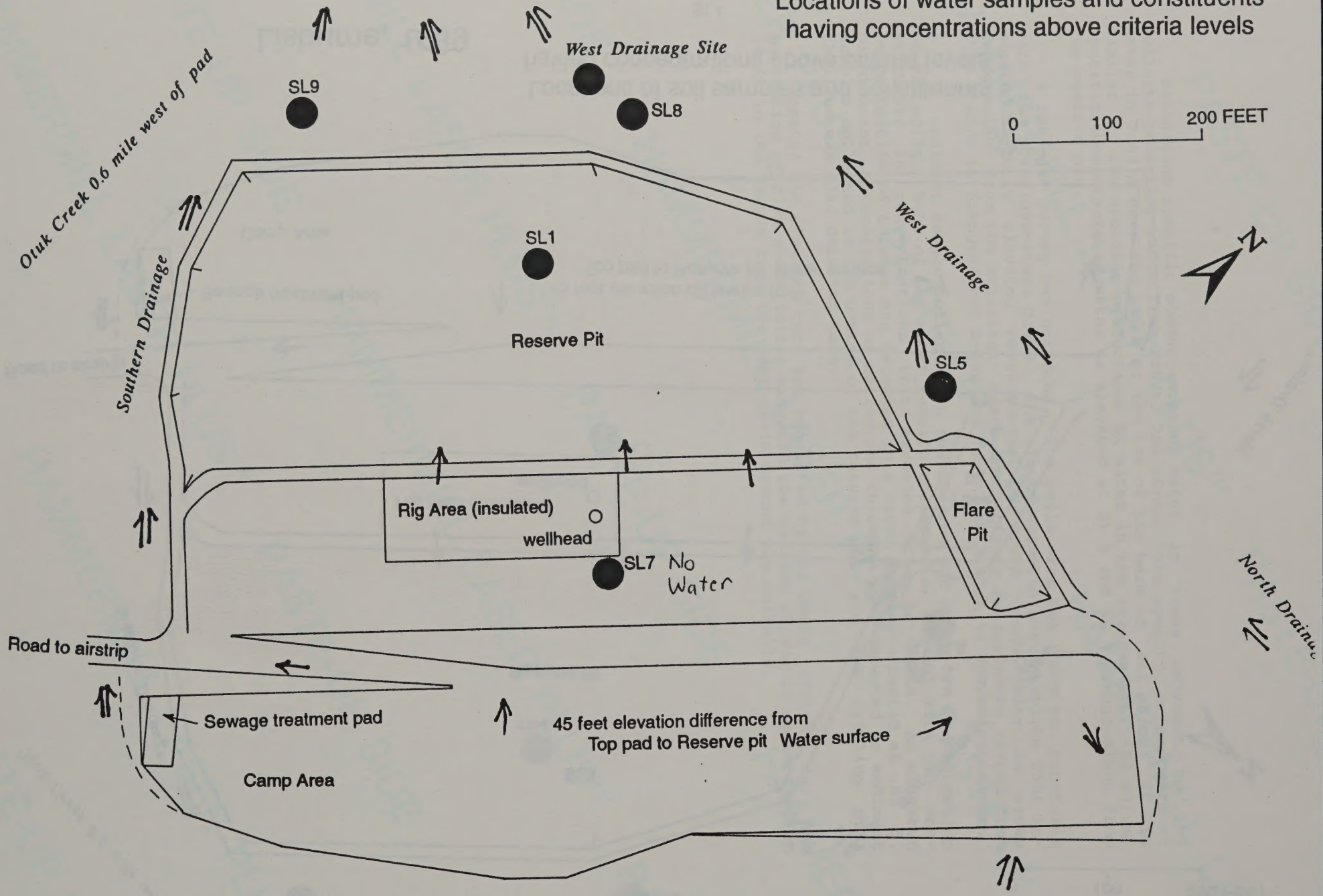


Locations of soil samples and constituents having concentrations above criteria levels.

Lisburne, 1989

SL4

Locations of water samples and constituents having concentrations above criteria levels



Lisburne, 1989

SL4

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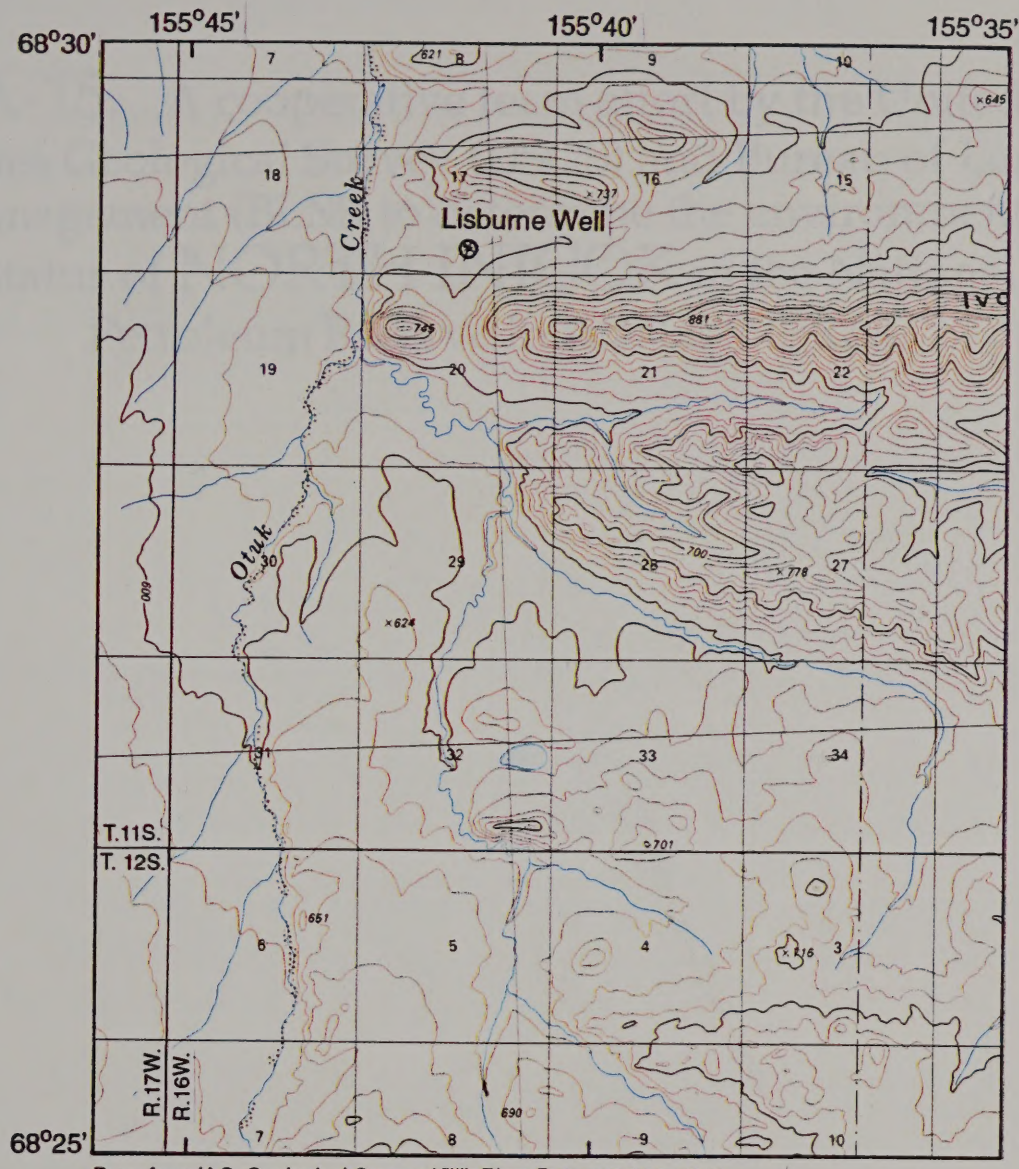
08-07-89 BLM 1:4000 LISBURNE 18-3-19



Base from U.S. Geological Survey, Killik River B-5, 1:63,360, 1984

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 20 METERS
DATUM IS SEA LEVEL

Location of Lisburne well.

A-15. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of NORTH INIGOK in the National Petroleum Reserve in Alaska (NPRA).

15 WELLSITE RISK DETERMINATION
NORTH INIGOK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sample History	1981(TETRA TECH)1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1980,1982
Leakage/Seepage	Small amount of seepage from North side of pit
Erosion	None
Subsidence	None
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Good, blending into surrounding area
Natural Processes	Modified drainage patterns being reestablished
Waste	
Drilling	Not backfilled covered with up to 5 feet of water
Other Solids	None observed
Hydrocarbon Residue	Elevated TPH 50 feet downgradient
Contaminant Level	Although the standard of 80 was exceeded one time in the 1989 sampling program (86 mg/kg) the concentration is below the 1991 State standard (100 mg/kg)
Contaminant Migration	none using 1991 standards
Contaminant Persistence	Site more than 12 years old. No contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	No basis for concern

North Inigok

Location and Drilling Characteristics

Latitude: 70°15′27.32" *Longitude*: 152°45′57.53"

Location: T. 11 N., R. 4 W., Sec 36 SE 1/4. Umiat Meridian

Depth: 10,170 ft *Drilled:* 2/13/81 - 4/4/81

Description

North Inigok Test Well No. 1 (plate 16A) is located about 113 mi southeast of Barrow. The wellsite, which is along the crest of a low, stabilized, vegetated sand dune ridge, is 136 ft above sea level. Several shallow ponds are near the wellsite. Water-quality samples for metal analysis were collected at the wellsite by Tetra Tech (1983) in February and March 1981. The wellsite was visited in 1989 but not in 1990.

Drilling Pad: A thin pad was used. The pad was constructed using material, mostly sand, obtained from excavation of the reserve pit. The site was seeded and fertilized in 1981.

Reserve and Flare Pits: Both pits are open, not backfilled. The reserve pit was constructed by deepening a pond to a depth of about 5.5 ft. The low berm between the reserve and flare pits is eroding by wave action, and free exchange of water occurs between the pits. Water in the reserve pit might overflow into areas adjacent to the wellsite during periods of high precipitation or spring snowmelt. Water from the reserve pit was not flowing through a large breach on the northern side of the pit during the 1989 site visit, but some water might be seeping through the active layer to the low side of the berm in the breach area. A small amount of surface water was flowing into the reserve pit from the southwest.

Summary of Reconnaissance Visit

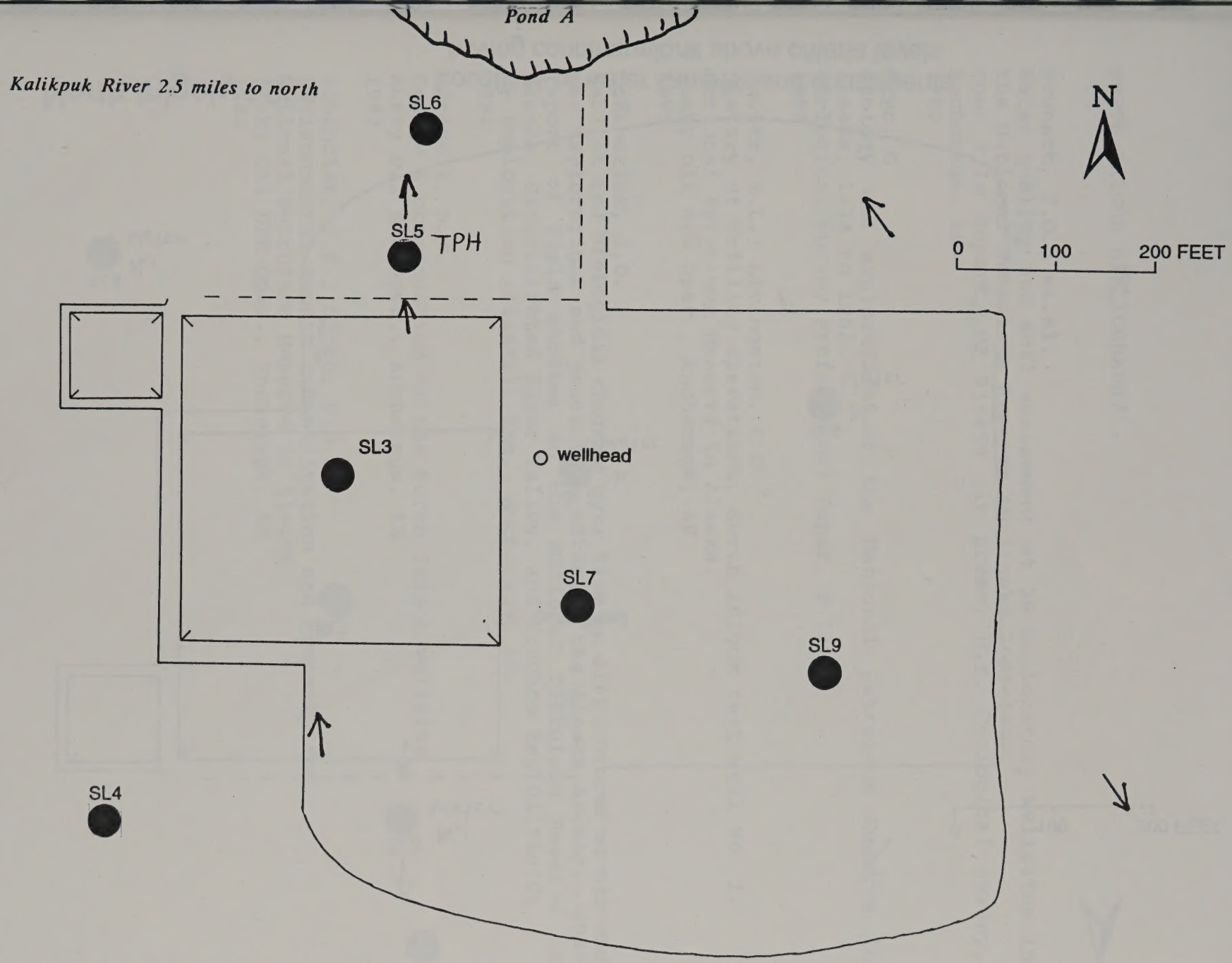
Drainage from nearby ponds and the surrounding tundra is in a northwesterly or southeasterly direction from the crest of the ridge where the wellsite is located. Clearly established channels draining the area, however, are not apparent.

Local flow directions are controlled by a series of southwest-northeast trending vegetated dunes, one of which forms a low divide through the wellsite. Most of the wellsite drains toward the north, but the southwestern part of the pad drains toward the southeast. Grasses are growing on the drilling pad, except in areas where sandy soils are resistant to vegetative growth and are eroded by wind.

The electromagnetic survey indicated no elevated earth-conductivity measurements (plate 16B). The soil-gas survey indicated a soil-gas concentration of 260 Vppm at SL 9 (plate 16C).

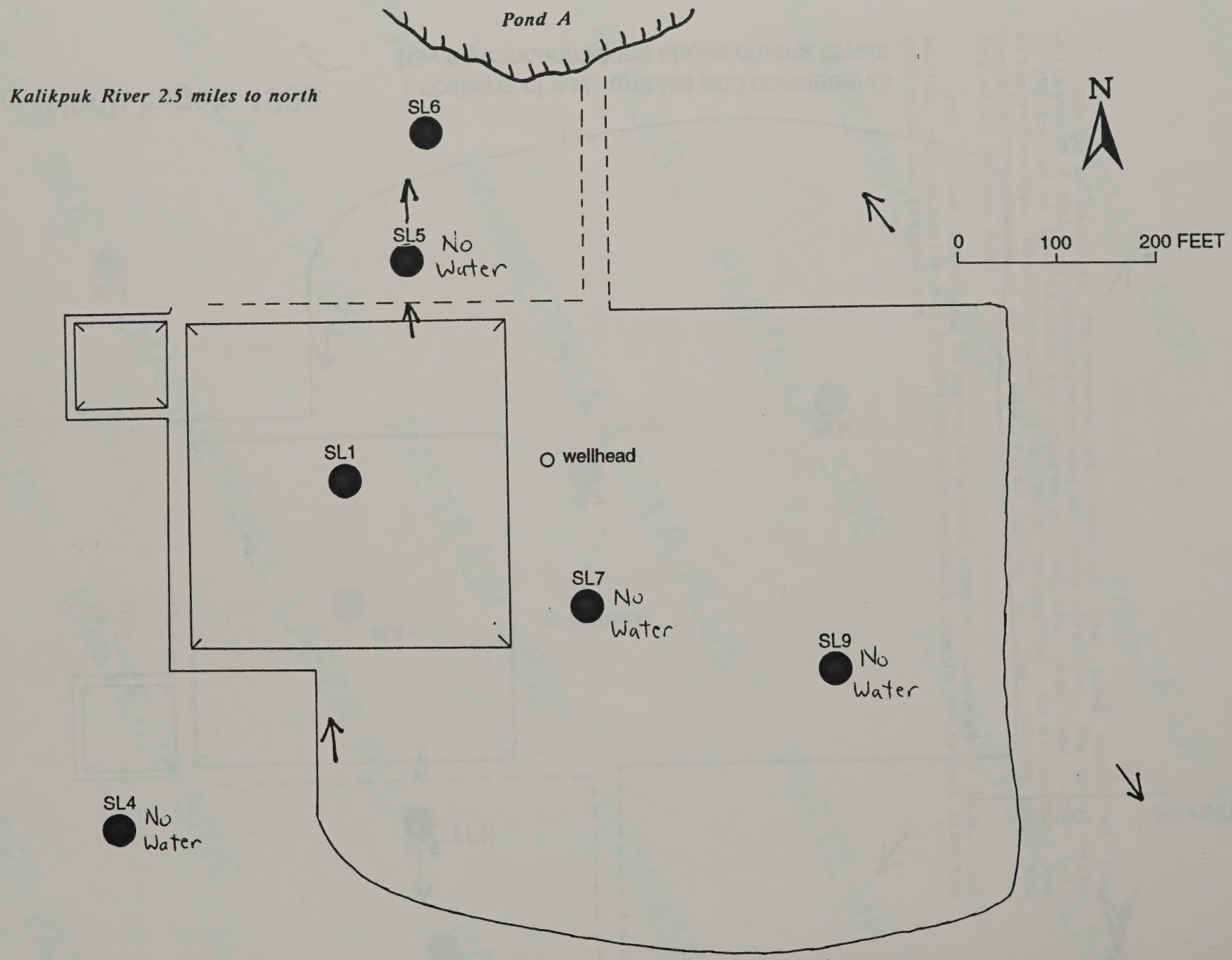
The pH of water in the reserve pit and in the pond north of the wellsite (9.4 and 9.3, respectively) was strongly alkaline. The pH of water in the ground at SL 6 between the reserve pit and the pond was only 7.0. Dissolved-oxygen concentrations were near saturation in all ponds. The specific conductance of water was 1,050 µS/cm in the reserve pit and 146 µS/cm in the pond.

TPH concentration was 86 mg/kg in a soil sample collected at SL 5, and barium concentration was 11,100 mg/kg in sediment sample collected from the bottom of the reserve pit.



North Inigok, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



North Inigok, 1989

Locations of water samples and constituents having concentrations above criteria levels

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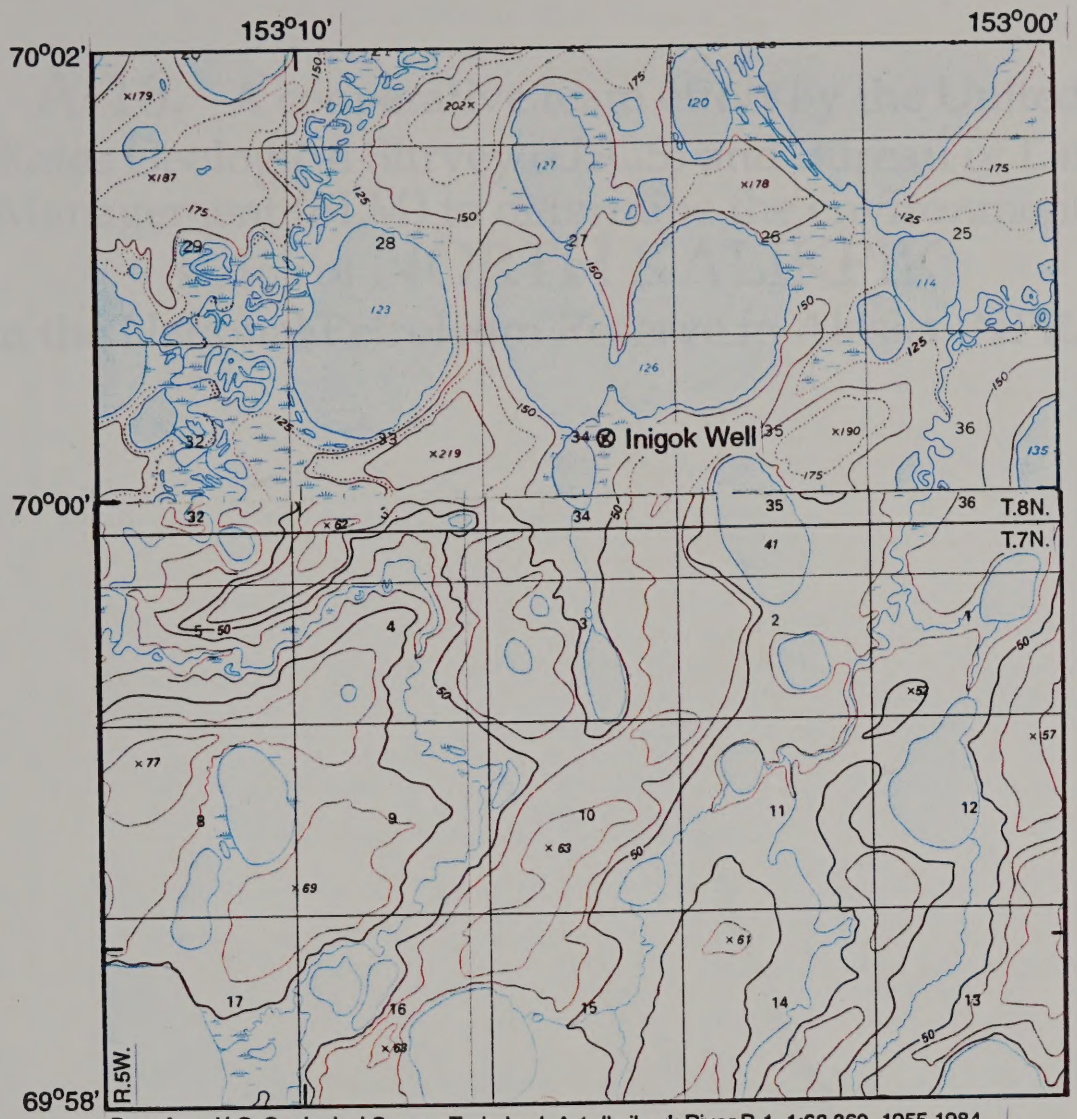
08-06-89 BLM 1:4000
INIGOK 12-2-10



Base from U.S. Geological Survey, Teshekpuk A-1, Ikpikpuk River D-1, 1:63,360, 1955,1984

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL
CONTOUR INTERVAL 10 METERS
(on bottom half of page)

Location of Inigok well.

A-16. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of NORTH KALIKPIK in the National Petroleum Reserve in Alaska (NPRA).

16. WELLSITE RISK DETERMINATION
NORTH KALIKPIK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sample History	1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1979, 1982. Pad material used to fill in pit.
Leakage/Seepage	Reestablishing normal flows
Erosion	None
Subsidence	Pond on top of backfill
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Beginning to reestablish vegetation
Natural Processes	Normal drainage patterns being reestablished
Waste	
Drilling	Covered with pad material and 3 feet of water
Other Solids	None
Hydrocarbon Residue	None
Contaminant Level	None
Contaminant Migration	None
Contaminant Persistence	Site more than 14 years old-No contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	No basis for concern
Risk to Human Population	No basis for concern
RISK DETERMINATION	No basis for concern

North Kalikpik

Location and Drilling Characteristics

Latitude: 70°30′33.023" *Longitude*: 152°22′04.169"

Location: T. 13 N., R. 2 W., Sec. 3 SW 1/4, Umiat Meridian

Depth: 7,395 ft *Drilled*: 2/27/78 - 4/14/78

Description

North Kalikpik Test Well No. 1 (plate 17A) is located about 113 mi southeast of Barrow. No water-quality data were available prior to the 1989 sampling. The site was visited in 1989 but not in 1990.

Drilling Pad: A thick pad was used. The pad and berms were constructed using materials obtained from a sand bluff along an unnamed creek 4 mi southeast of the wellsite. The site was seeded and (or) fertilized in 1979 and 1982.

Reserve and Flare Pits: The pits were backfilled with thawed sand, but differential settlement has left ponded water over parts of the fill. Two large breaches along the northwestern part of the berm allow water to drain from the fill. The berm around the flare pit appears to be intact.

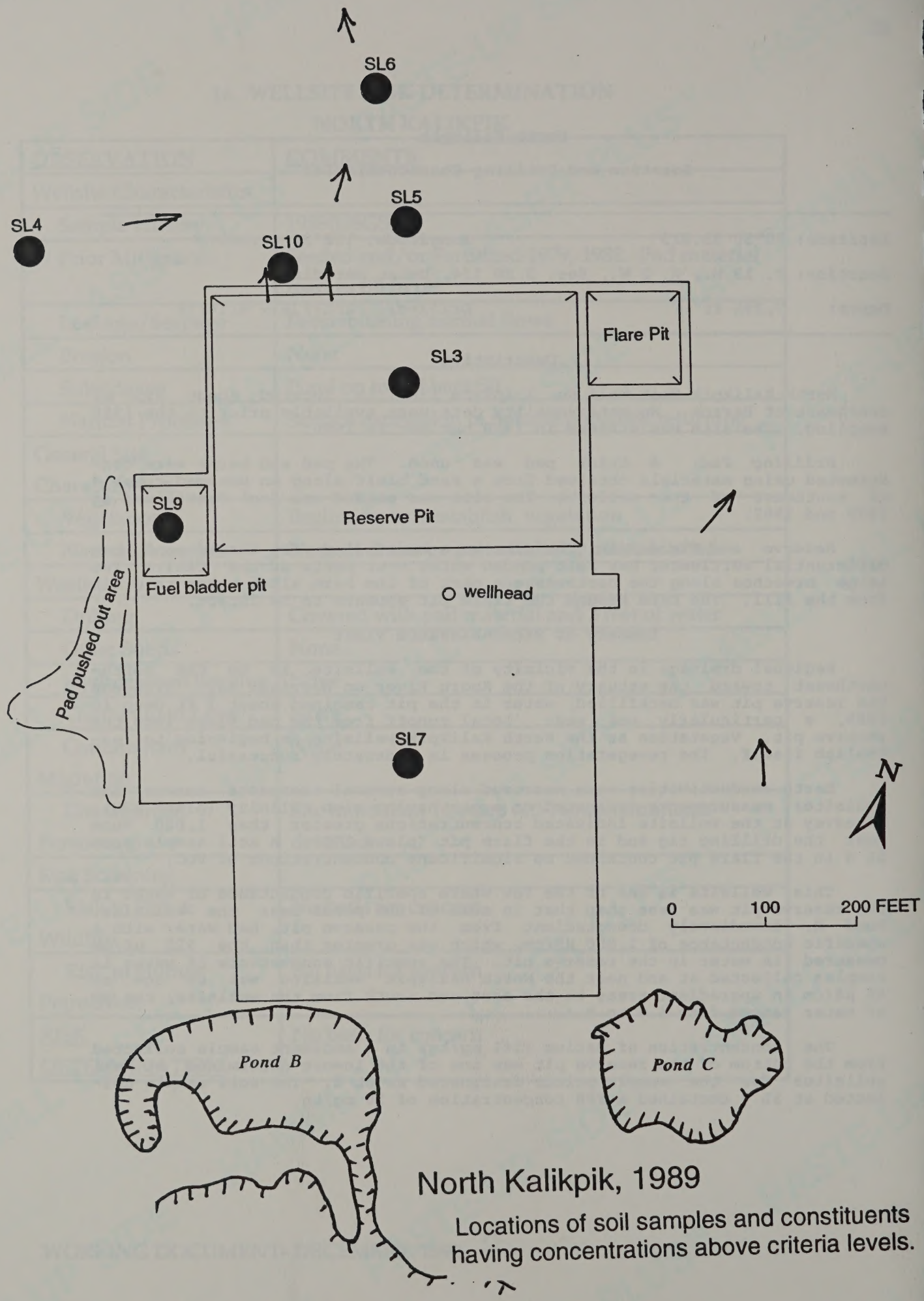
Summary of Reconnaissance Visit

Regional drainage in the vicinity of the wellsite is to the north-northwest toward the estuary of the Kogru River on Harrison Bay. Although the reserve pit was backfilled, water in the pit remained about 3 ft deep in 1989, a particularly wet year. Local runoff from the pad flows into the reserve pit. Vegetation at the North Kalikpik wellsite is beginning to establish itself. The revegetation process is moderately successful.

Earth conductivities were measured along several transects across the wellsite; measurements indicated no areas having high salinity (plate 17B). A survey at the wellsite indicated concentrations greater than 1,000 Vppm near the drilling rig and in the flare pit (plate 17C). A soil sample from SL 9 in the flare pit contained no significant concentrations of VOC.

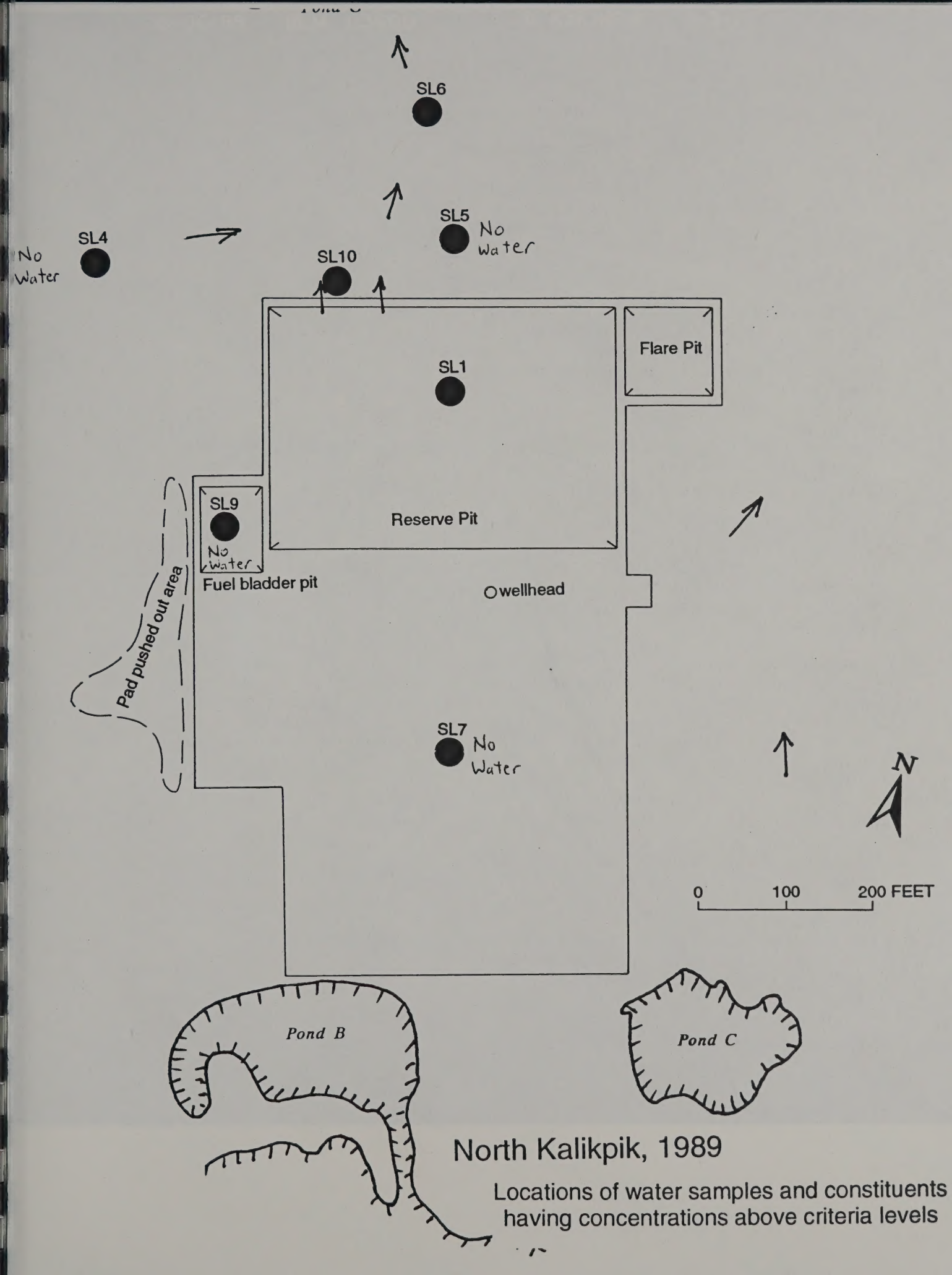
This wellsite is one of the few where specific conductance of water in the reserve pit was less than that in some of the ponds near the wellsite. Pond H, immediately downgradient from the reserve pit, had water with a specific conductance of 1,800 µS/cm, which was greater than the 922 µS/cm measured in water in the reserve pit. The specific conductance of water in samples collected at and near the North Kalikpik wellsite was as low as 66 µS/cm in upgradient areas to the east and south from the wellsite; the pH of water ranged from 6.0 to 9.4.

The concentration of barium (541 mg/kg) in a sediment sample collected from the bottom of the reserve pit was one of the lowest determined at all wellsites for the sample points designated as SL 3. The soil sample collected at SL 7 contained a TPH concentration of 50 mg/kg.



North Kalikpik, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



North Kalikpik, 1989

Locations of water samples and constituents having concentrations above criteria levels

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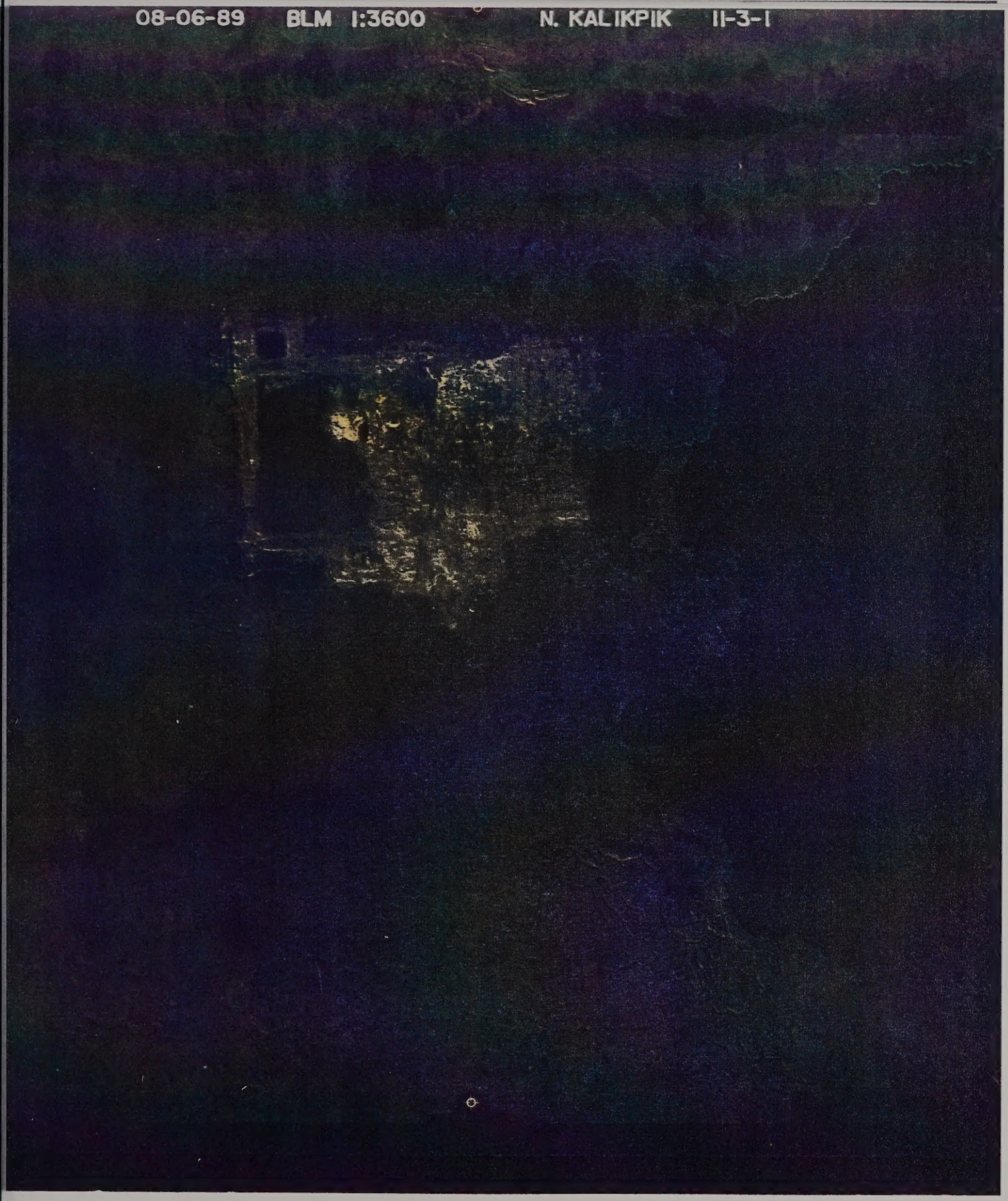
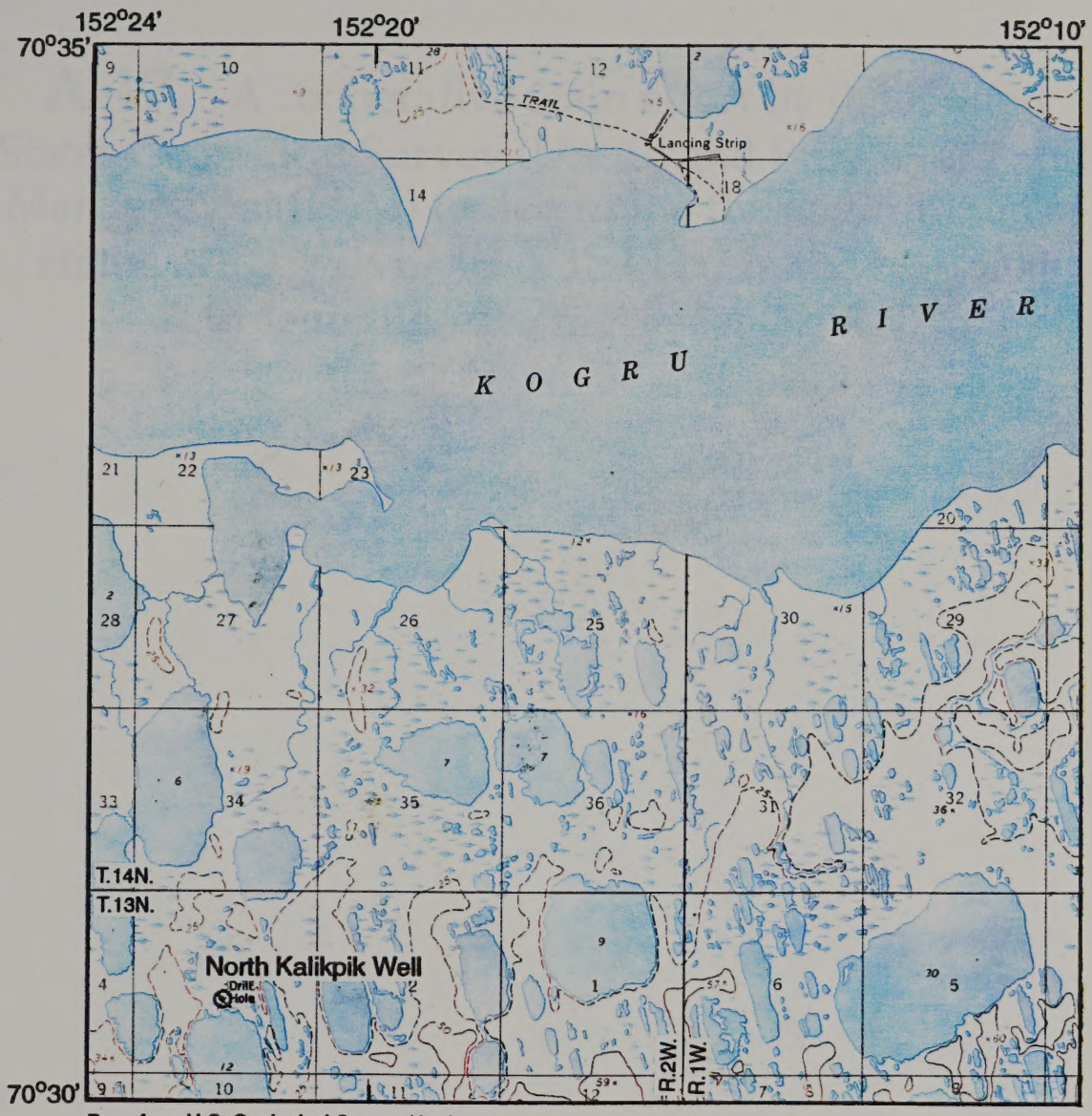
1983

08-06-89 BLM 1:3600 N. KALIKPIK II-3-1





Base from U.S. Geological Survey, Harrison Bay C-4, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of North Kalikpik well.

A-17. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of PEARD (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

17. WELLSITE RISK DETERMINATION

T.W. PEARD

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA), 1989,1990 (USGS)
Prior Mitigation	Seeded and/or Fertilized 1979,1980, 1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Pad and pit subsidence through melting of underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Vegetation is poor probably due to salinity
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Waste buried under 7 feet of water
Other Solids	None observed
Hydrocarbon Residue	Highly elevated BTEX and TPH
Contaminant Level	BTEX and TPH elevated levels above background
Contaminant Migration	Insignificant
Contaminant Persistence	Associated with sediments. Site more than 13 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible- BTEX expected to decrease over time due to volatility of the compounds

Peard

Location and Drilling Characteristics

Latitude: 70°42′56.321" *Longitude*: 159°00′02.512"

Location: T. 16 N., R. 28 W., Sec. 25 NW 1/4, Umiat Meridian

Depth: 10,225 ft *Drilled*: 1/26/79 - 4/13/79

Description

Peard Test Well No. 1 (plate 18A) is about 6 mi south of Peard Bay and about 64 mi southwest of Barrow on relatively flat terrain in a drained lake basin. The ground is about 70 ft above sea level. The wellsite was seeded and fertilized in 1979, 1980, and 1982, and fertilized in 1981. Water-quality samples were collected by the Nuera Reclamation Company in July 1984. The site was visited in 1989 and in 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/14/84	9.0-11.8 °C	9.3-9.5	950-1,000 µS/cm	Nuera Reclamation Company (1986, p.46-47)

Drilling Pad: A thin pad was used. The pad and berms were constructed using ice-rich materials that were excavated from the reserve pit. On thawing, the pad settled to within a few inches of the original tundra elevation.

Reserve and Flare Pits: The pits are open, not backfilled. The berms around the pits have deteriorated as a result of the thermokarst process and wave action. Breaches are present on all sides of the pits. The top of the eastern berm is below or at water level in the pit. Ground deformations caused by thawing of ice wedges and thermokarst action have encroached on the boundaries of the reserve pit; the perimeter of the pit has become irregular in shape. The depth of water was about 7 ft in July 1984.

Summary of Reconnaissance Visits

The Peard wellsite is swampy and has low relief. The regional flow of water near the wellsite is to the east and south. Many ponds that existed on the pad during the wet year of 1989 had dried up by 1990. Revegetation is poor, and bare mud exists over most of the wellsite area.

The electromagnetic survey indicated background earth conductivity measurements of 8-9 mS/m (plate 18B). Water on the eastern side of the reserve pit was too deep to permit access by foot, so the area immediately east of the reserve pit was not surveyed for earth conductivity. Slightly elevated earth conductivity measurements south of the wellsite and in dry parts to the east indicated that water from the reserve pit drained to the south and east of the wellsite.

A soil-gas survey done at the wellsite in 1989 was not meaningful because conditions were too wet (plate 18C). Another survey done during dry conditions in 1990 indicated elevated concentrations of soil gas in the

drilling pad (plate 18E). Soil samples collected at the northeast pad pit and several soil samples near the fuel pit were collected on the basis of these elevated soil-gas measurements.

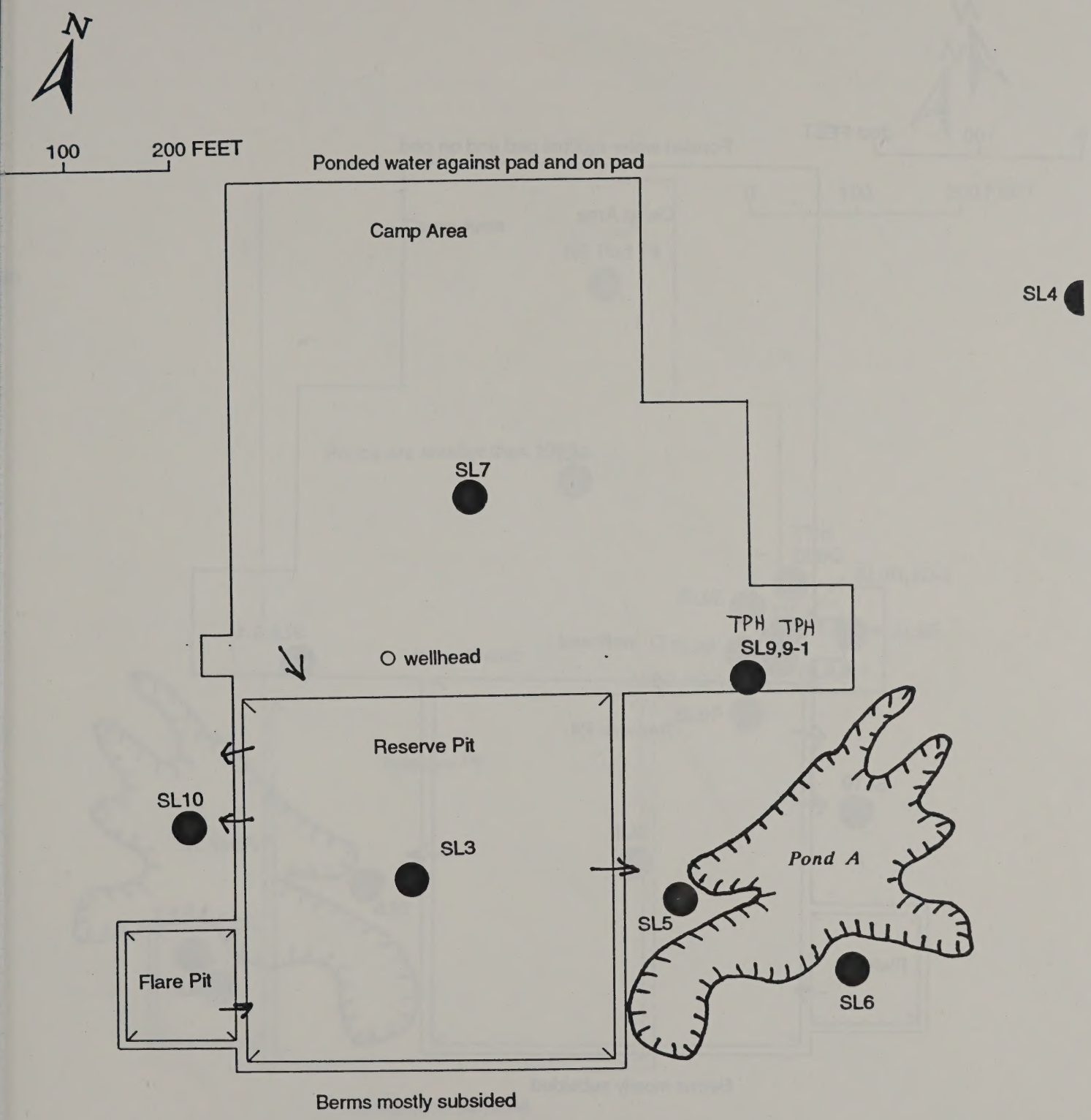
The specific conductance of water in the reserve pit was 1,470 µS/cm in 1989 (plate 18A) and 1,320 µS/cm in 1990 (plate 18D). Specific conductance of water in background samples ranged from 150 to 220 µS/cm; this indicated that natural water near the wellsite has fewer chemical constituents than water in the reserve pit and water in areas adjacent to the pad and the reserve pit.

The pH of water in all ground-water samples collected in 1989 and in 1990 was slightly acidic, ranging from 5.7 to 6.6. The pH of water in surface water samples generally were neutral or alkaline.

In 1989, BTEX concentration in a sediment sample collected at SL 9-1 was 9.3 mg/kg, all as xylene. This concentration significantly exceeds the MCL of 1.0 mg/kg. Sediment samples collected in 1990 for confirmation of 1989 results indicated that two sediment samples collected from SL 9G and three collected from SL 9 again contained BTEX concentrations that exceeded the MCL. A water sample at SL 9G contained ethyl benzene at a concentration of 270 µg/L and xylene at a concentration of 1,700 µg/L. In 1990, 5 out of 12 soil samples from 8 locations in the fuel pit contained BTEX in concentrations exceeding the PMCL.

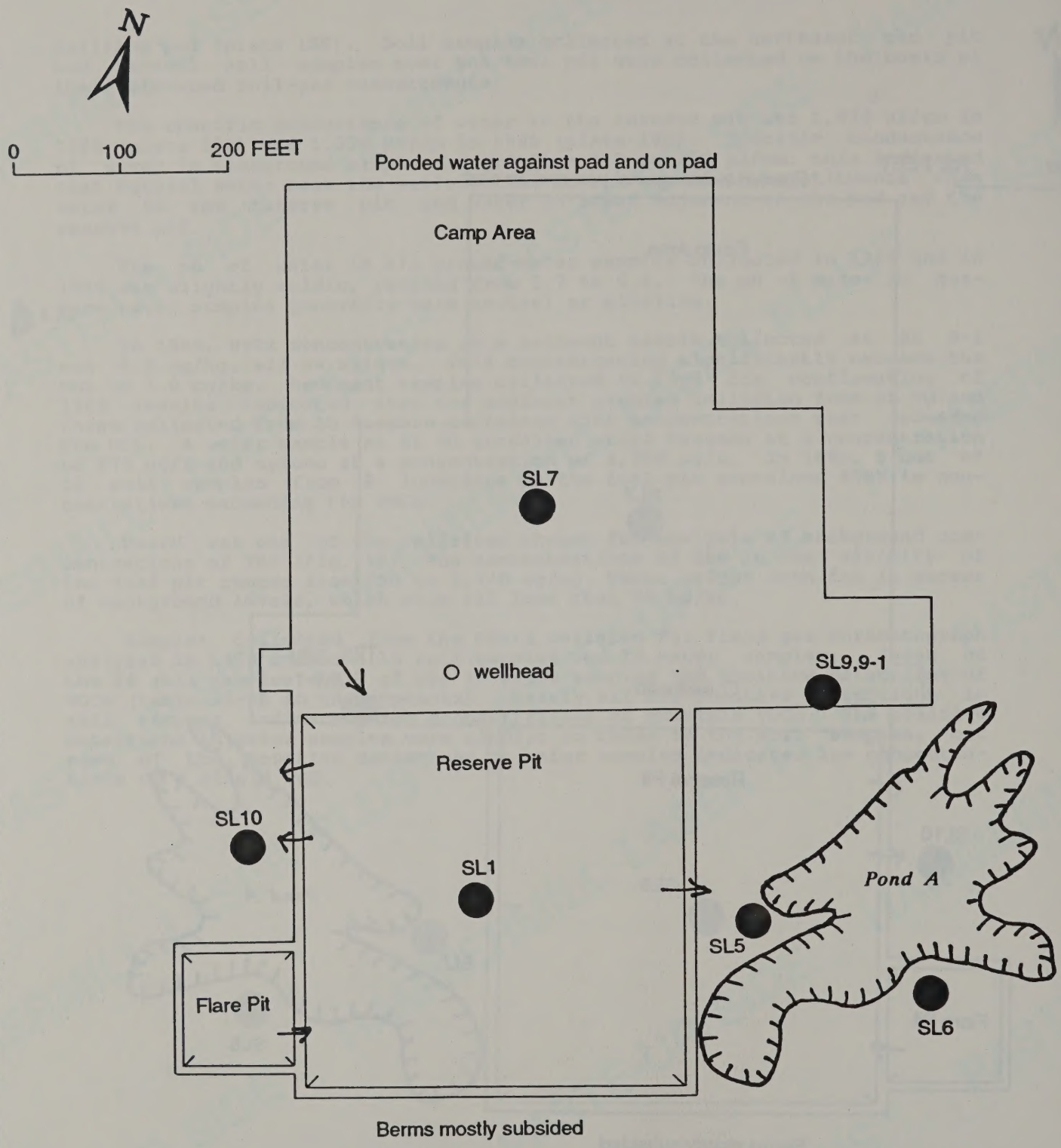
Peard was one of the wellsites chosen for analysis of background concentrations of TPH (fig. 12). The concentrations of TPH in the vicinity of the fuel pit ranged from 255 to 1,440 mg/kg. These values were far in excess of background levels, which were all less than 80 mg/kg.

Samples collected from the Peard wellsite for field gas chromatograph analyses in 1990 included 16 soil samples and 10 water samples. Seven of the 16 soil samples and 7 of the 10 water samples had positive detections of VOCs (table 12-PE in the appendix). Nearly all the positive detections in soil samples indicated high concentrations of multiple VOCs. The positive detections in water samples were similar to those in the soil samples, but some of the positive detections in water samples indicated low concentrations of a single VOC.



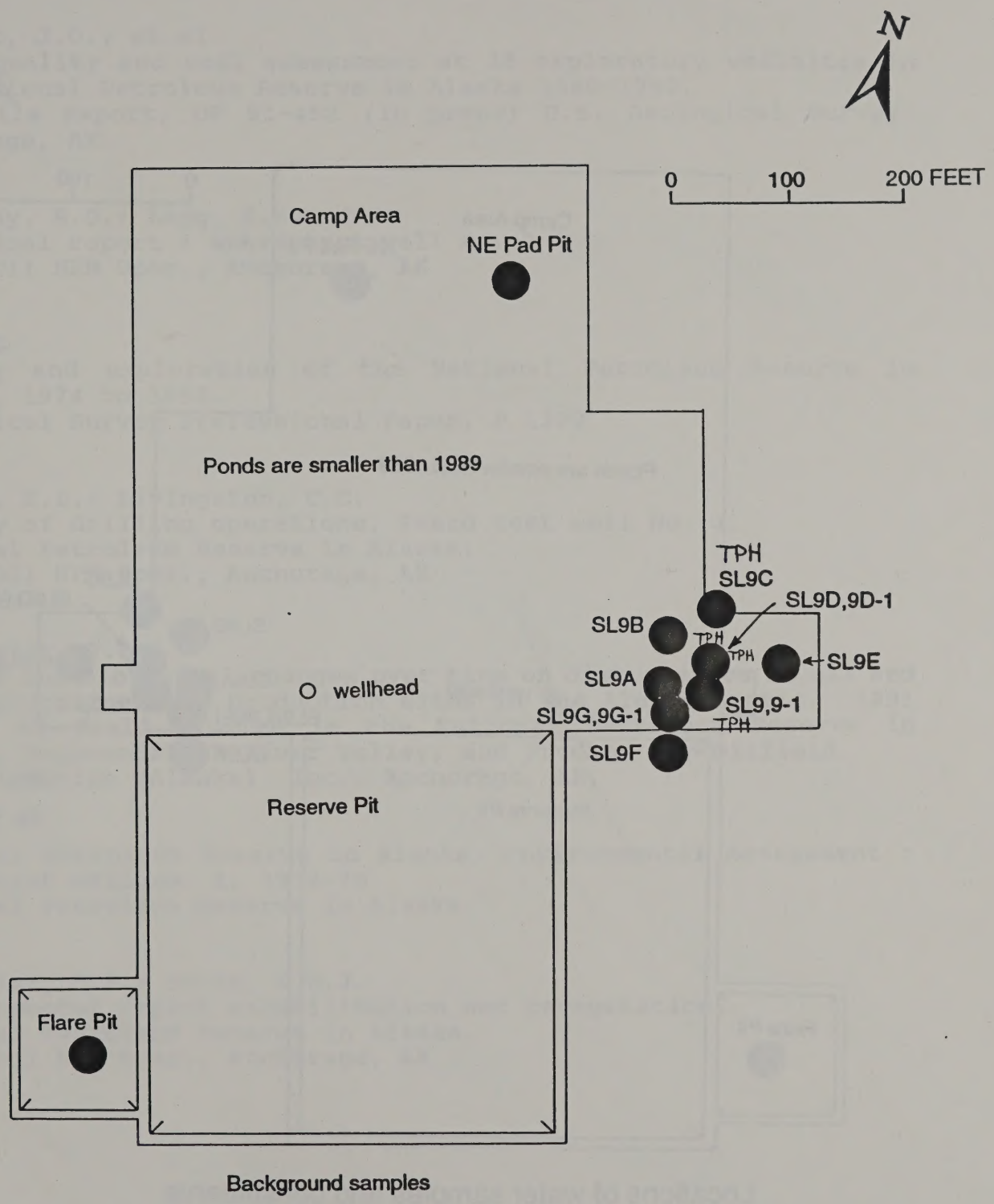
Locations of soil samples and constituents having concentrations above criteria levels.

Peard, 1989



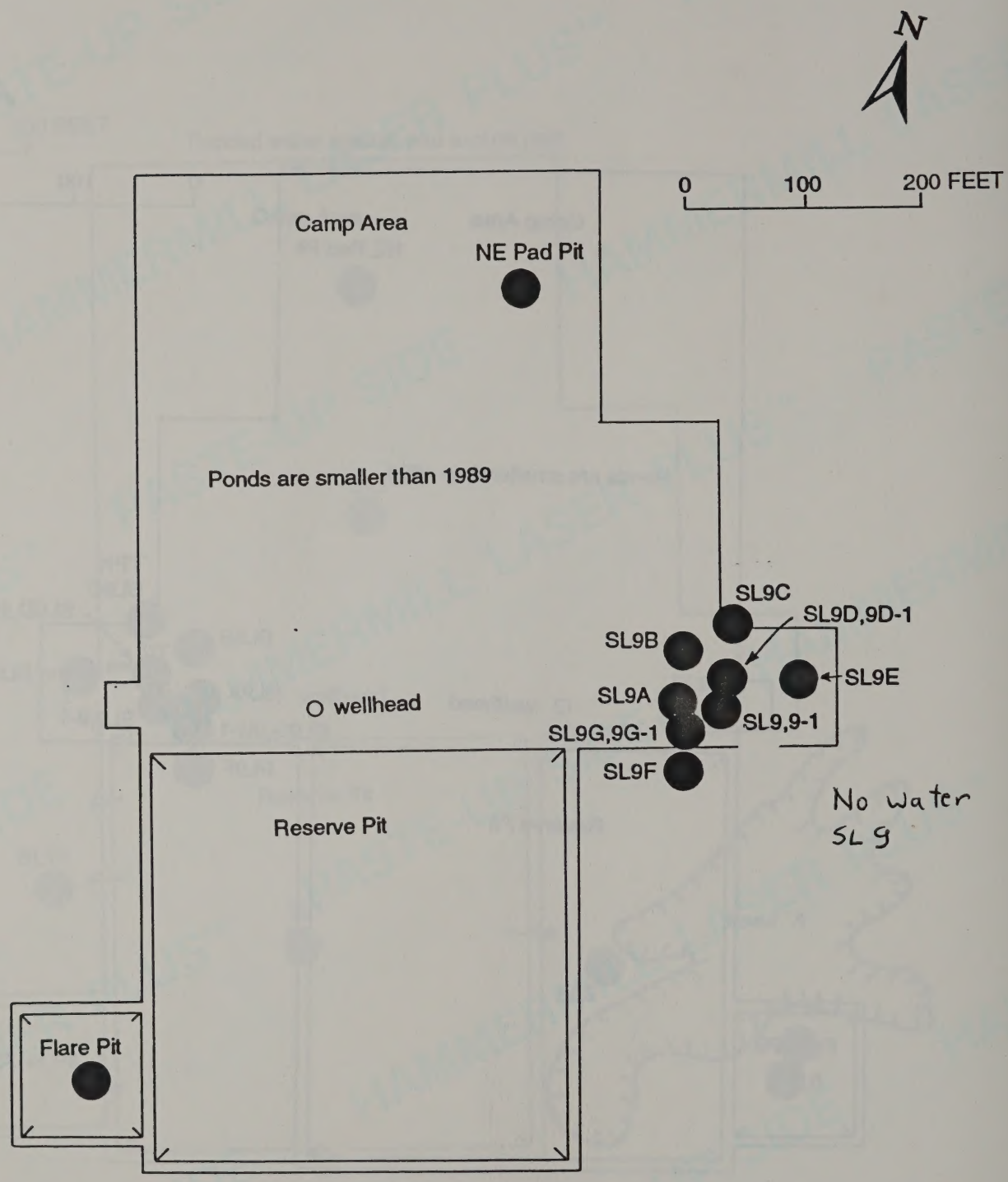
Locations of water samples and constituents having concentrations above criteria levels

Peard, 1989



Peard, 1990

Locations of soil samples and constituents having concentrations above criteria levels.



Locations of water samples and constituents having concentrations above criteria levels

Peard, 1990

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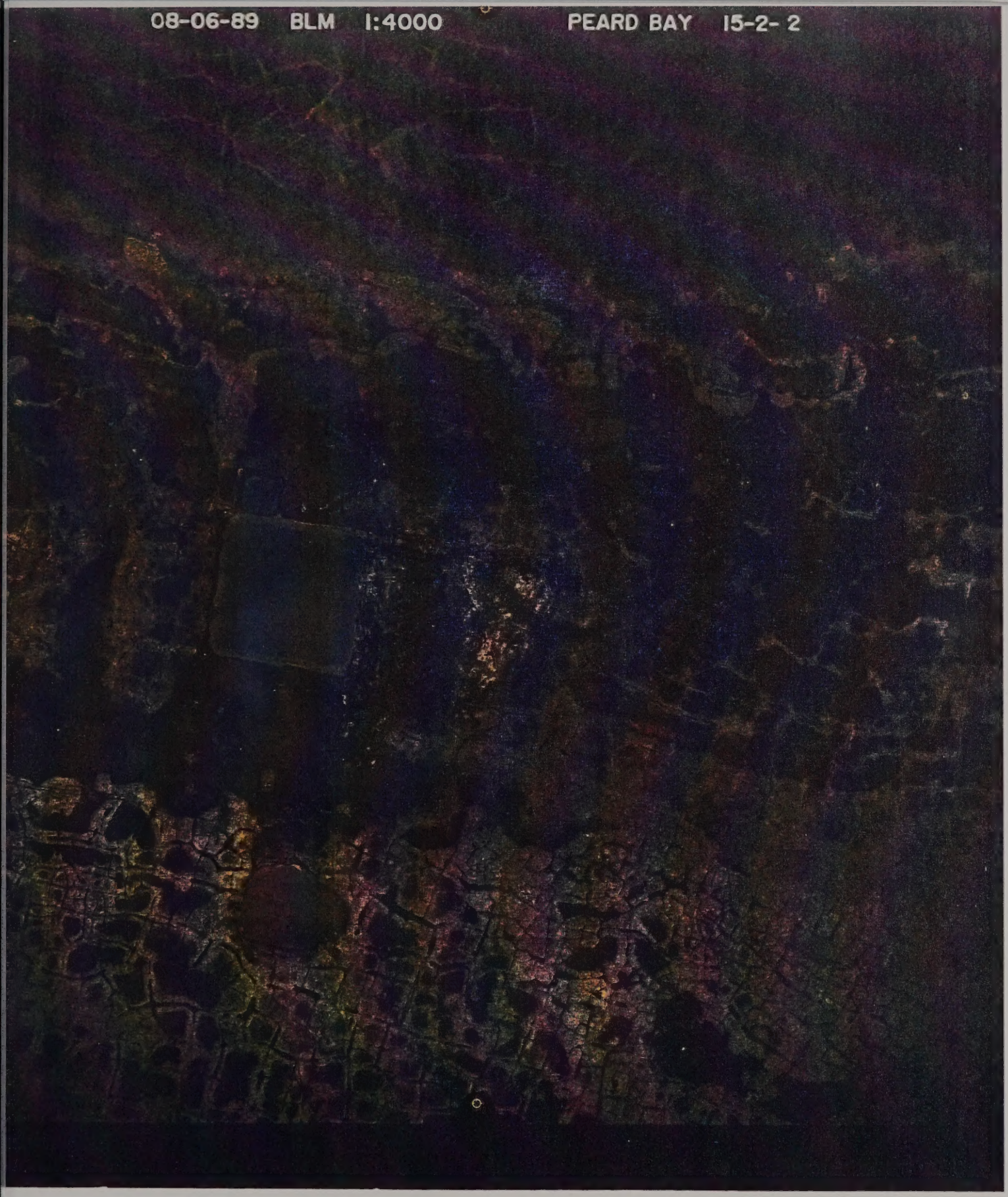
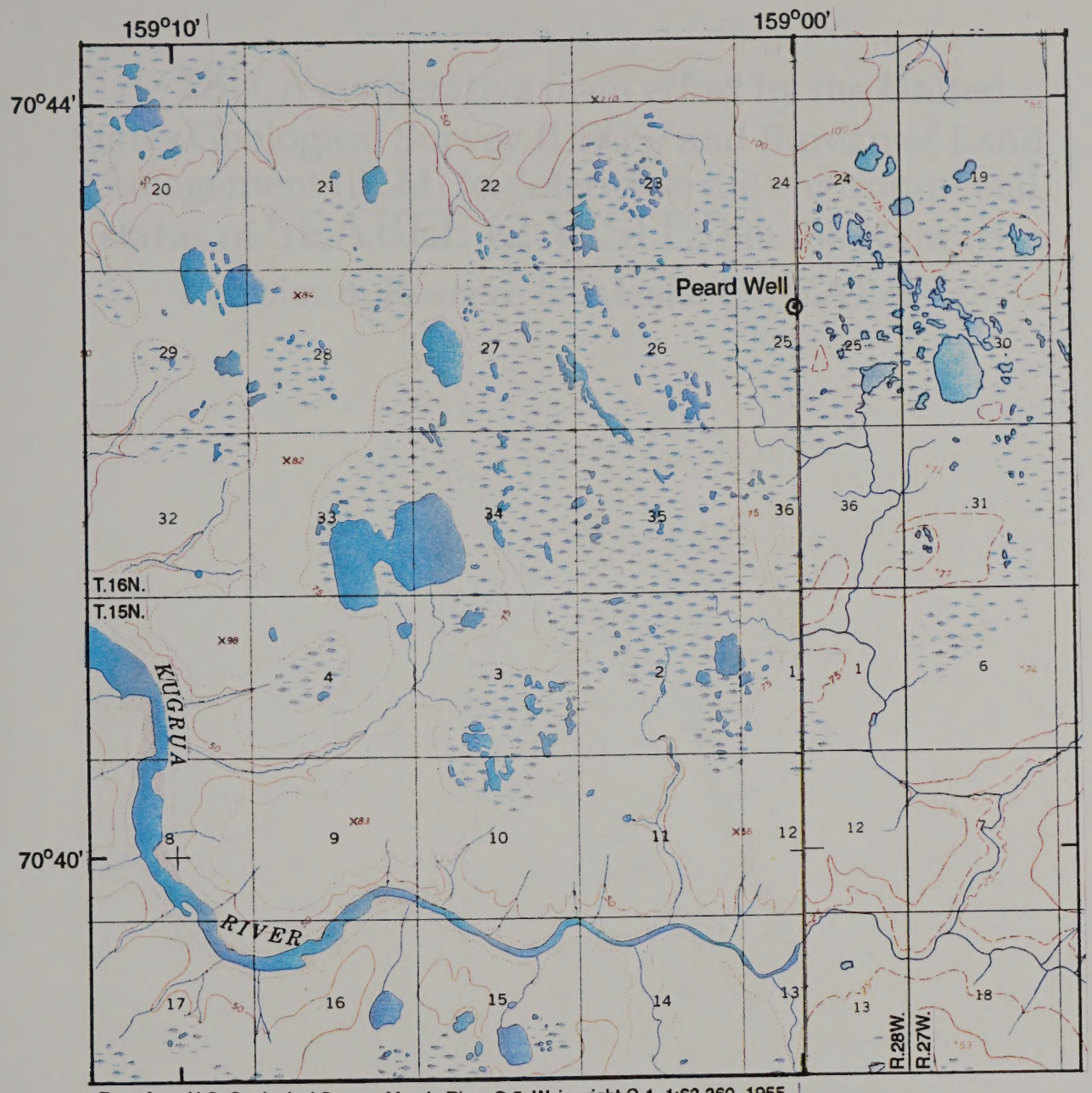
08-06-89 BLM 1:4000 PEARD BAY 15-2- 2





Base from U.S. Geological Survey, Meade River C-5, Wainwright C-1, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of Peard well.

A-18. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of SEABEE (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).A-

18. WELLSITE RISK DETERMINATION
SEABEE

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1983,1989,1990(USGS) 1984(NUERA)
Prior Mitigation	Seeded and Fertilized 1981,1982
Leakage/Seepage	Natural surface water into and out of pit
Erosion	None
Subsidence	None observed
Natural Processes	Surface expression of natural polygons in fuel pit- none on insulated portions of gravel pad
General Site Characteristics	
Vegetation	Sparse on pad
Natural Processes	Natural drainage reestablished on fuel pit and not on insulated/gravel pad
Waste	
Drilling	TPH elevated above background, Barium in 1989 survey- Barium is below 1992 MCLs and chromium elevated above MCL
Other Solids	None observed
Hydrocarbon Residue	TPH elevated above background in flare and reserve pits and elevated 100 feet downslope from pit
Contaminant Level	Barium and Chromium elevated above MCL. TPH elevated above background
Contaminant Migration	Chromium and Barium found outside pit but no contaminants sampled in Seabee creek
Contaminant Persistence	Associated with sediments in pits but somewhat mobile outside pits. Site is more than 12 years old
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible-occasional human visits to pad and airstrip 1-1/2 mile away
RISK DETERMINATION	Negligible

Seabee

Location and Drilling Characteristics

Latitude: 69°22′48.519" *Longitude*: 152°10′31.291"

Location: T. 1 S., R. 1 W., Sec. 5, SE 1/4, Umiat Meridian

Depth: 15,611 ft *Drilled*: 7/1/79 - 7/21/79 and 10/21/79 - 4/15/80

Description

Seabee Test Well No. 1 (plate 19A) is located about 1.2 mi northwest of Umiat and about 172 mi southeast of Barrow. A gravel road connects the wellsite to a gravel airstrip at Umiat. Rehabilitation of the site was done during the summers of 1980, 1981, and 1982. The site was seeded and fertilized in 1981 and 1982. Water-quality samples were collected by USGS in August 1983 and by the Nuera Reclamation Company in July 1984. The site was visited in 1989 and in 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT
[USGS, unpublished data on file in the District Office of the U.S. Geological Survey, Anchorage, Alaska; Nuera, Nuera Reclamation Company]

Date	Temperature (°C)	pH	Specific conductance (µS/cm)	Reference
8/16/83	6.0	8.2	1,400-1,450	USGS (1984)
7/16/84	13.6-15.5	7.9-8.0	660-700	Nuera(1986, p. 134)

Drilling Pad: A thick pad was constructed using sand and gravel material with styrofoam insulation and a plastic liner. The sand and gravel for the pad and berms was obtained from a borrow site on Seabee Creek. No signs of erosion at the wellsite were detected in 1989. The pad is stable but sparsely vegetated.

Reserve, Flare, and Fuel Pits: All pits are open, not backfilled. Thermokarst action has caused deterioration of the berms. As a result, water in the reserve pit has breached the berms in numerous places. Surface water flowing from the upgradient areas enters the reserve pit through its northern side and exits the pit through several breaches on the southern and western sides. In 1984, oil-stained sediment was observed above the waterline and algae were growing along the waterline in the pit. Water depth in the reserve pit was about 4.8 ft on July 16, 1984. The outer berm of the flare pit is breached in several places. The berm between the reserve and fuel pits has settled because of thermokarst action, but is still above the water level observed in either pit.

Summary of Reconnaissance Visits

Water in the reserve pit is dark brown and when the bottom sediment in the pit is disturbed, swirls of multicolored sheen appear on the water surface. Drainage in the wellsite area is generally to the south. Vegetation at the wellsite is sparse.

The electromagnetic survey indicated that background earth-conductivity values in upgradient areas from the reserve pit (plate 19B) ranged from 2.8 to 3.0 mS/m. A slight increase in earth-conductivity values was detected (4.5 to 5.6 mS/m) near and in downgradient areas from the breach on the southern side of the reserve pit. This indicates movement of water from the pit to downgradient areas away from the pit.

The soil-gas survey for the organic vapor concentrations was not effective (plate 19C) because the coarse gravel was difficult to penetrate with the stainless-steel probe. In 1990, high organic vapor concentrations were detected in upgradient areas from the reserve pit (plate 19E); however, no water or sediment samples were collected from this area.

The specific conductance of water in the reserve pit was 395 µS/cm in 1989; this represents a significant reduction from the specific conductance values of 1,400 to 1,450 µS/cm determined in 1984 and 660 to 700 µS/cm determined in 1986. Background, or natural, water quality in lakes in nearby undisturbed areas is much more dilute. For example, Red Hill Lake, upgradient, and Pond K have specific conductances of 122 and 92 µS/cm, respectively.

In 1989, the pH of water in most samples collected at the wellsite areas was slightly acid to neutral (pH of 5.7 to 7.8). In 1989, the quality of water in the reserve pit was stratified as indicated by samples collected at SL 1 and SL 3. The chemistry of water in samples collected from the reserve pit in 1990 was insignificantly different (plate 19D) from that in samples collected in 1989. The reserve pit in 1990 was not stratified.

In 1989, barium concentrations in water exceeded the MCL of 1.0 mg/L in water samples collected at SL 1 (1.3 mg/L), SL 2 (1.5 mg/L), SL 5 (2.2 mg/L), and SL 6 (1.5 mg/L). These barium concentrations did not change significantly in 1990 as indicated by additional sampling. Analyses of five water samples collected in 1990 (including one collected in May) indicated that barium concentrations in water again exceeded the MCL. Chromium concentrations in the same 1989 water samples collected at SL 1, SL 2, SL 5, and SL 6 also exceeded the MCLs. In July 1990, nine sediment and eight water samples were collected to verify the chromium concentrations, particularly at those sites outside the boundaries of the reserve pit. The Seabee wellsite was one of eight at which chromium concentrations exceeded the MCL in water outside the boundaries of the reserve pit and pad. Eight water samples collected in July 1990 contained chromium concentrations that exceeded the MCL; all but one of the samples were collected outside the boundaries of the reserve pit. In 1989, lead in water samples from SL 1 (0.012 mg/L) and SL 2 (0.012 mg/L) also exceeded the MCL of 0.05 mg/L.

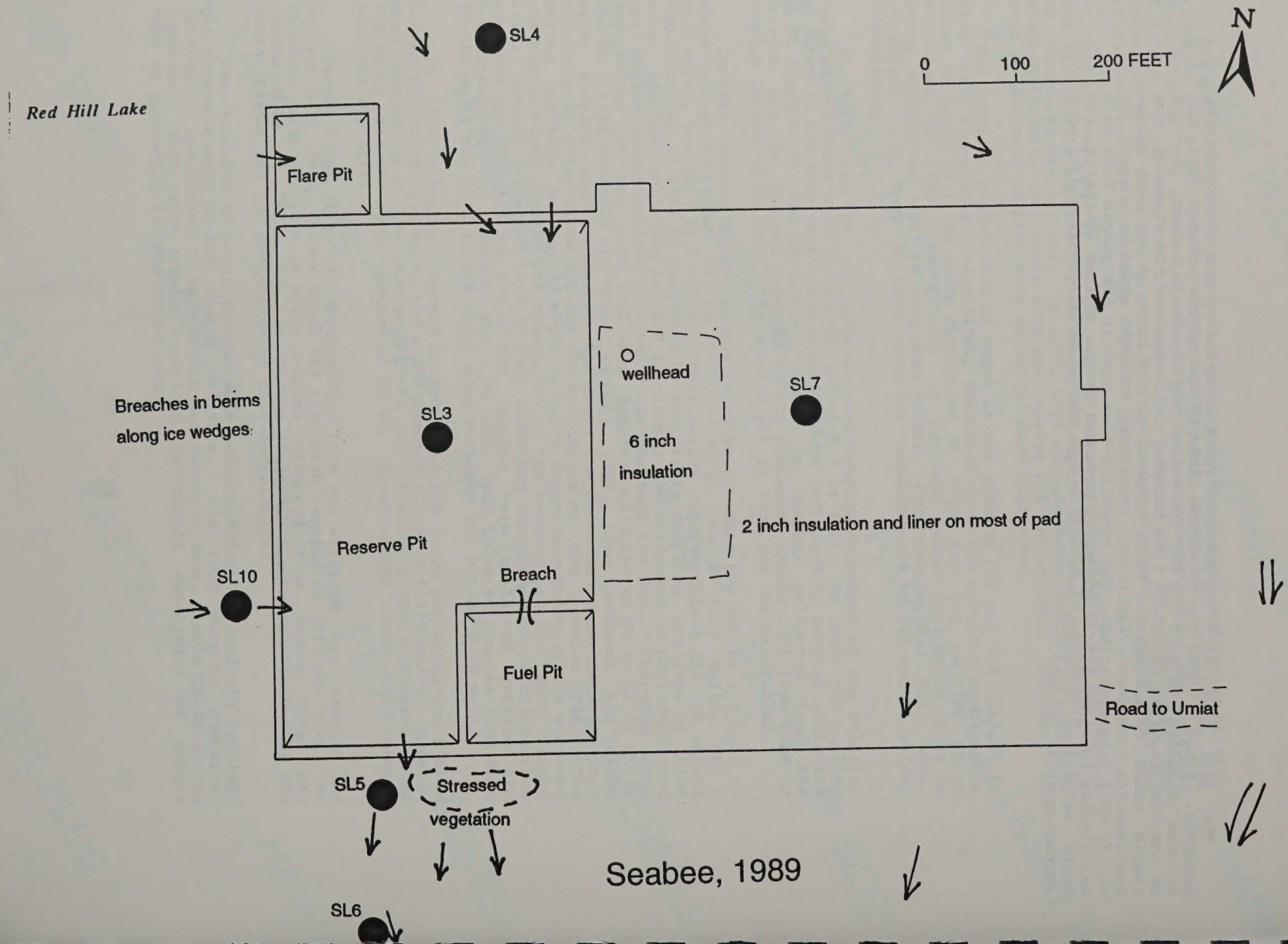
In 1990, a sediment sample collected in the flare pit contained a BTEX concentration of 10.6 mg/kg and a TPH concentration of 1,120 mg/kg. A sediment sample from the reserve pit (SL 3A) contained a TPH concentration of 868 mg/kg. The TPH concentration at SL 6B, downgradient from the reserve pit, was 175 mg/kg.

Seabee Creek (fig. 13) downgradient from the wellsite was sampled in May and July 1990. Seabee Creek had also been sampled in 1983 and 1984. No chemical concentrations in water samples collected from Seabee Creek exceeded MCLs or PMCLs or the maximum allowable limits established by the USEPA (1986b) for the protection of fish and wildlife.

Ten soil and 10 water samples were collected for VOC analysis by field gas chromatography at the Seabee wellsite. Six soil samples contained detectable quantities of both single and multiple VOCs, (table 12-SE in the appendix). Four water samples contained detectable quantities of single VOCs at apparently low concentrations.

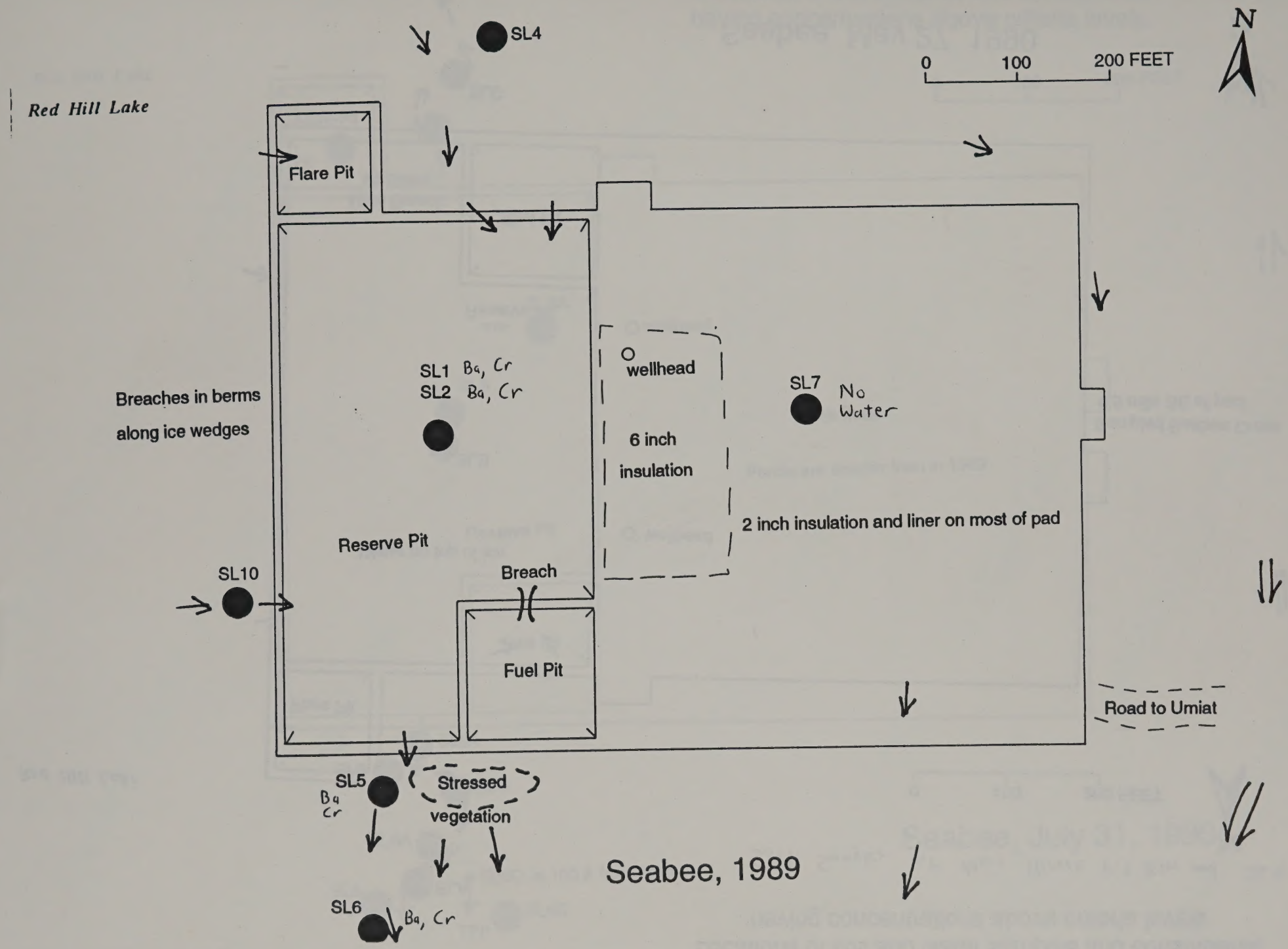
The soil from SL 6 was selected for second-column gas chromatography analysis. Table I shows the retention times of the sample unknown and the toluene standard on both the CSP-20M column and the SE-30 column. Because of the similarity in retention time between the sample and the standard, the sample could be interpreted to be toluene, on the basis of the dual-column confirmation procedure. Additional laboratory analysis would be needed to verify this interpretation. The retention-time peak in the sample from SL 6 was similar to other single VOC peaks detected at the Seabee wellsite and other wellsites, although not all single VOC peaks were analyzed on both chromatographic columns.

Locations of soil samples and constituents having concentrations above criteria levels.



Seabee, 1989

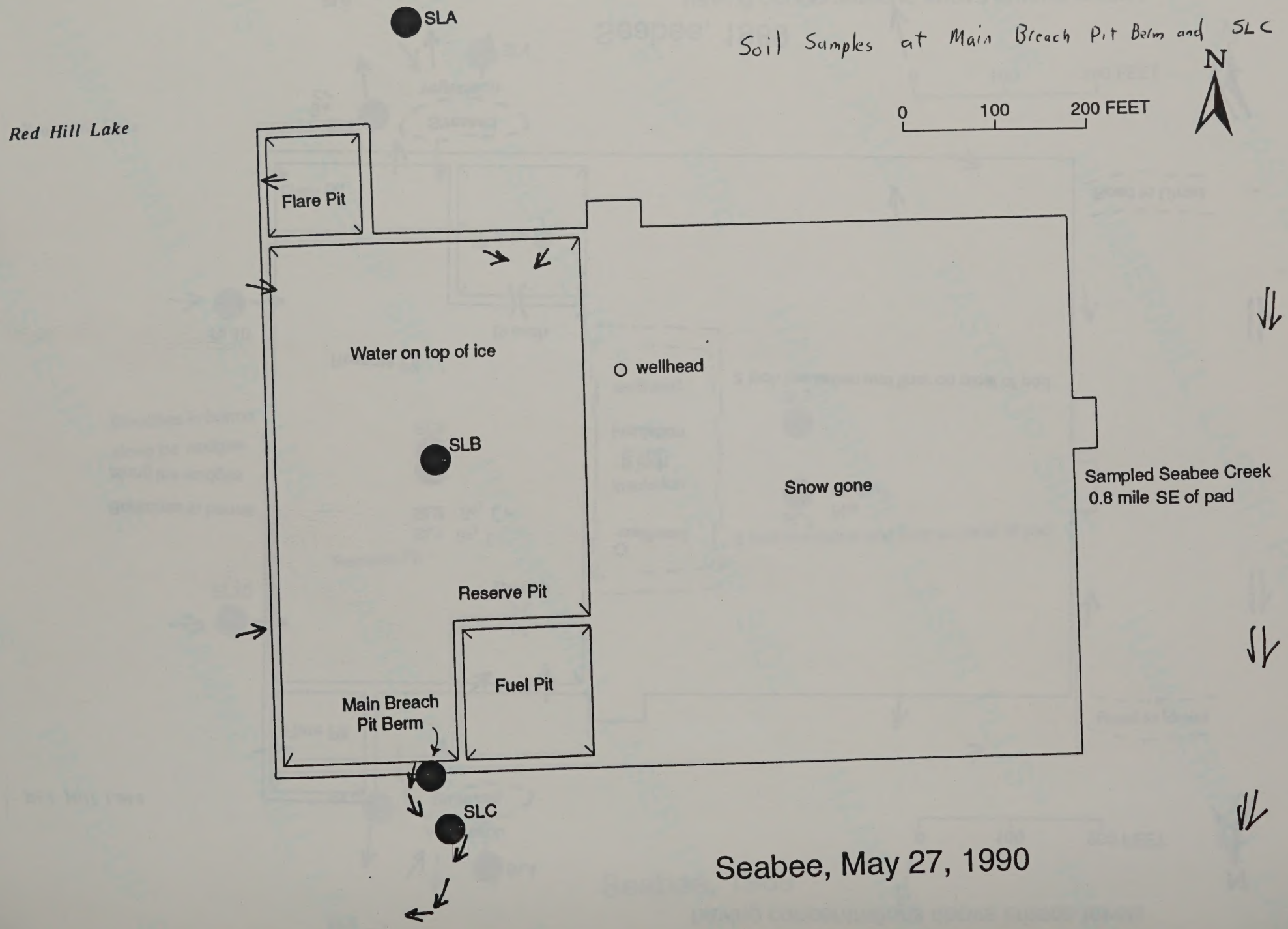
Locations of water samples and constituents having concentrations above criteria levels



Seabee, 1989

Locations of soil and water samples and constituents having concentrations above criteria levels

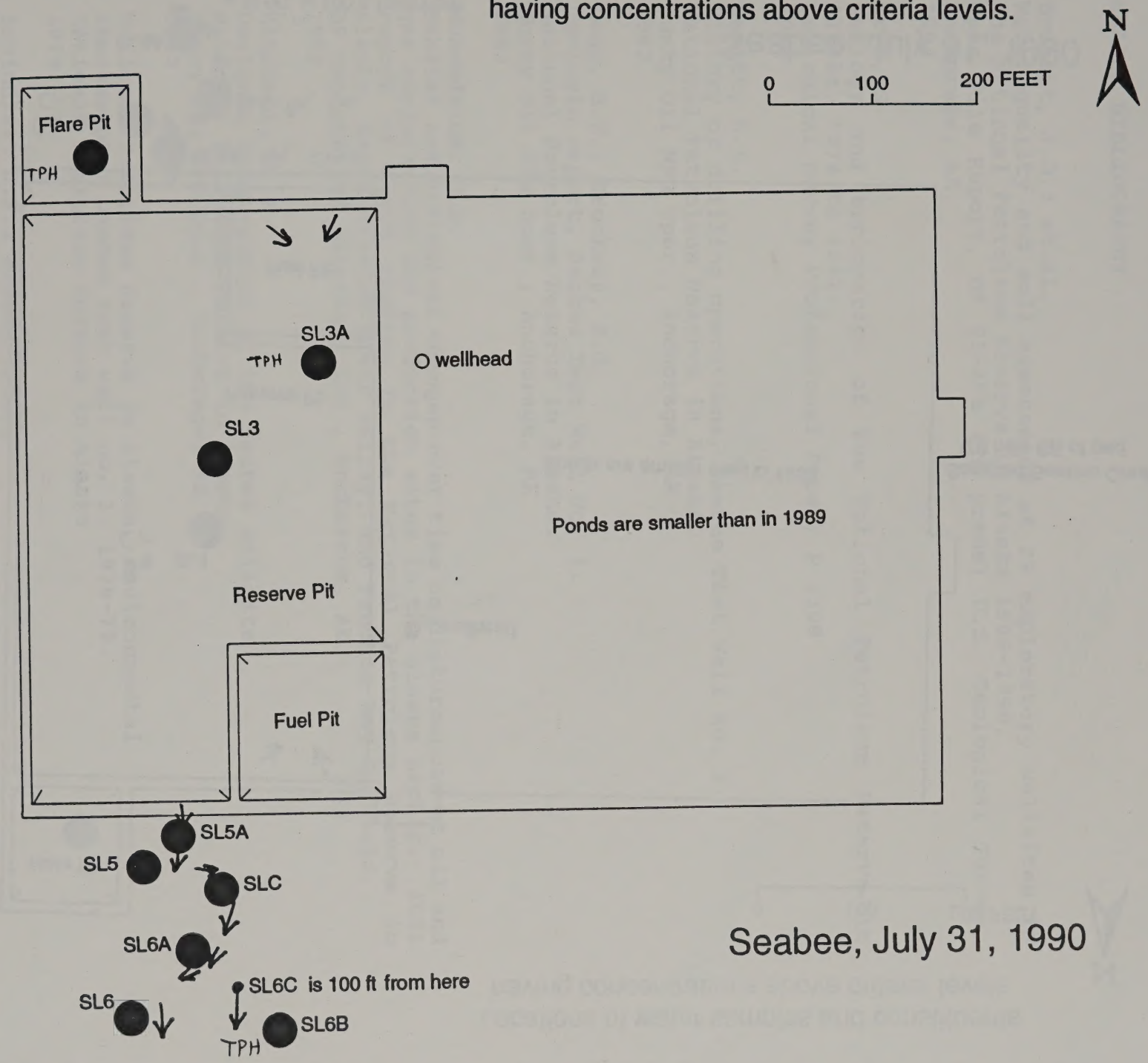
Soil Samples at Main Breach Pit Berm and SLC



Seabee, May 27, 1990

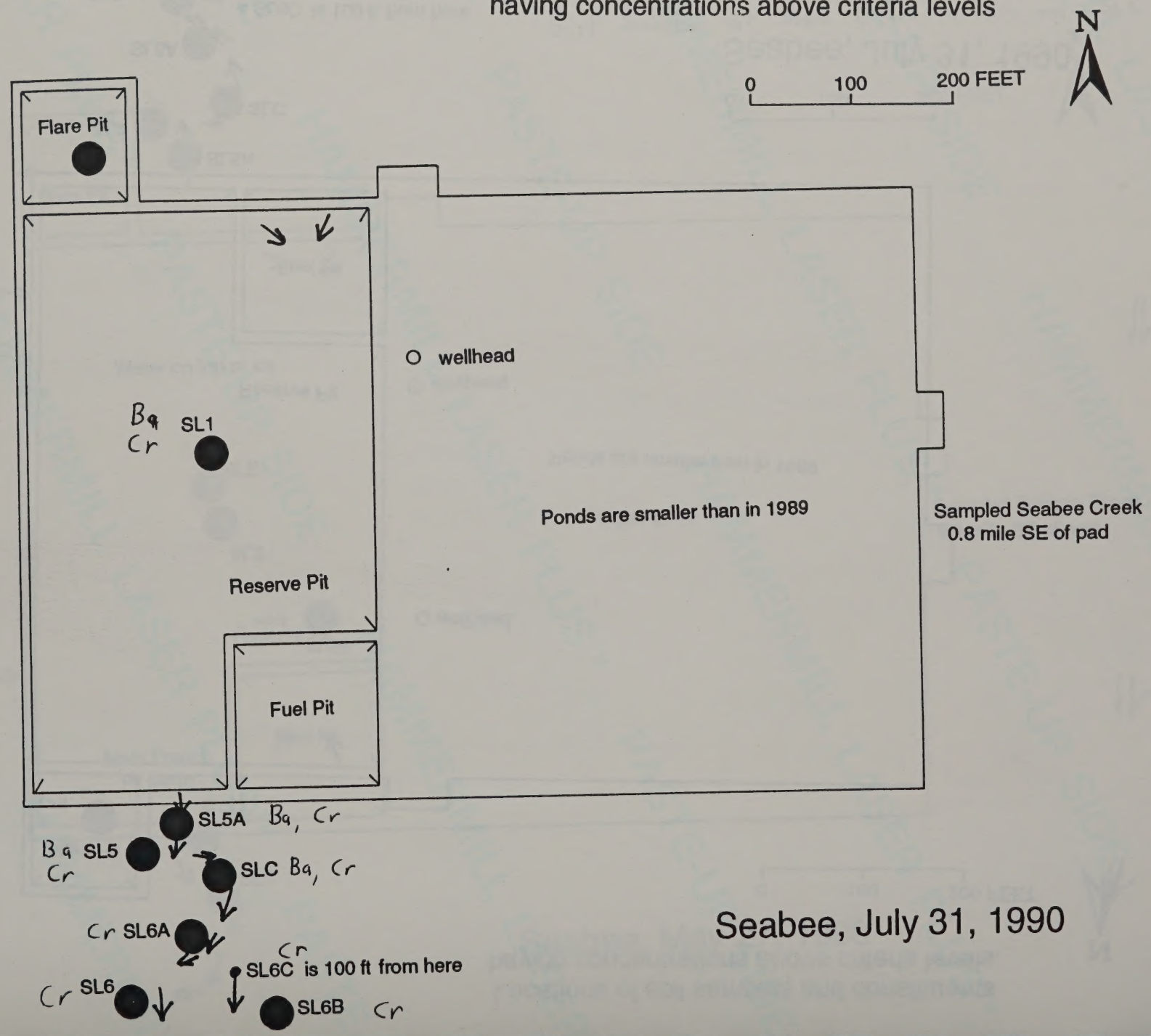
Locations of soil samples and constituents having concentrations above criteria levels.

Red Hill Lake



Seabee, July 31, 1990

Locations of water samples and constituents having concentrations above criteria levels



Seabee, July 31, 1990

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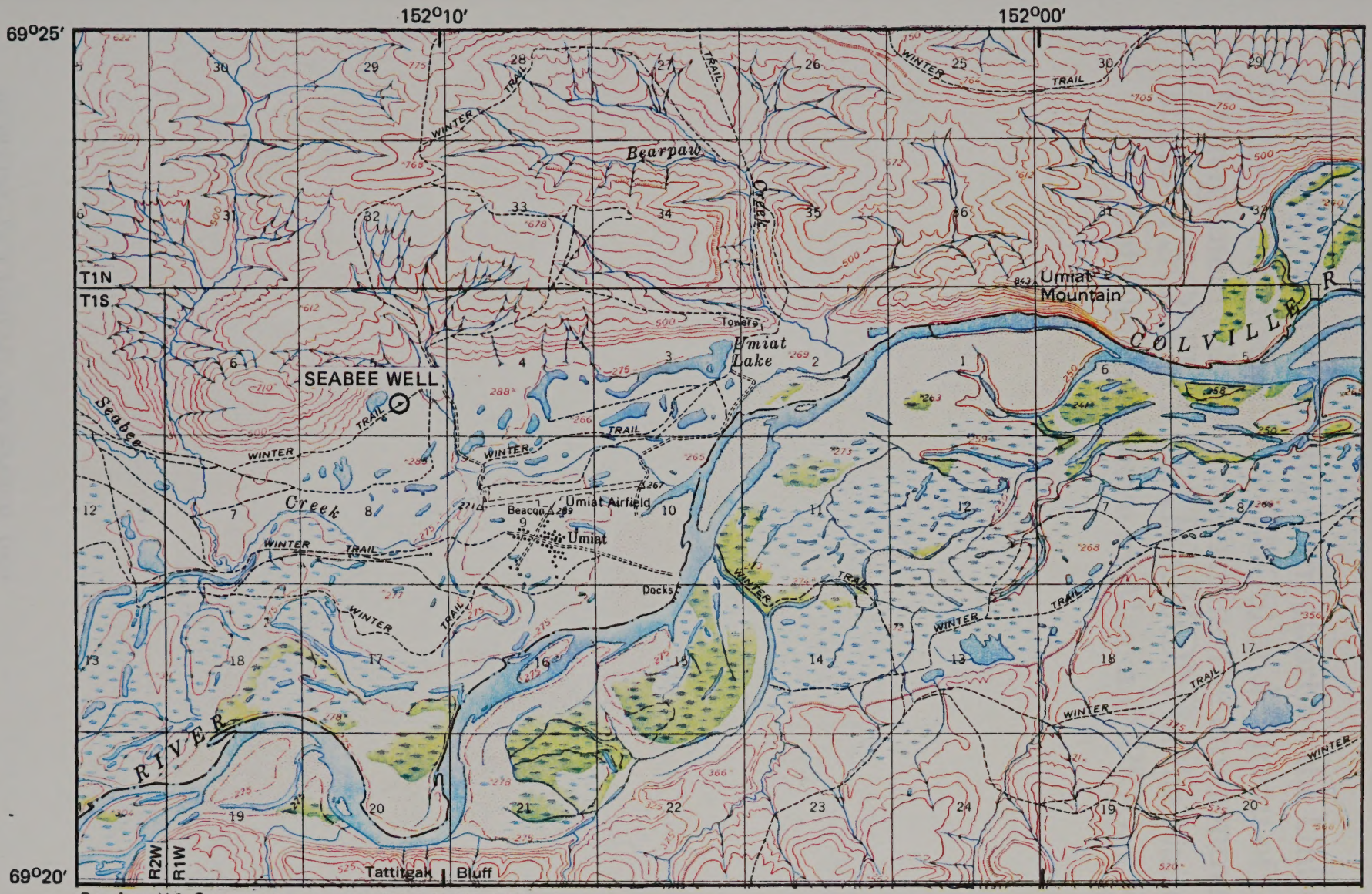
1983

08-06-89 BLM 1:4000 SEABEE 19-2-2



Base from U.S. Geological Survey, Umiat B-4, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of Seabee well.

A-19. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of SOUTH HARRISON in the National Petroleum Reserve in Alaska (NPRA).

19. WELLSITE RISK DETERMINATION
SOUTH HARRISON

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1978,1980. Pits backfilled and recontoured
Leakage/Seepage	Drainage into and out of pond formed over the former reserve pit
Erosion	None
Subsidence	Pit subsided through melting underlying ice; pond formed
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Vegetation on pad sparse, remainder of site good
Natural Processes	Blending in with natural environment
Waste	
Drilling	Buried in pit. Fill covered with 2 feet of water
Other Solids	None
Hydrocarbon Residue	TPH in soil-200 feet downgradient
Contaminant Level	Barium elevated above MCL in 1989 survey-Barium is below 1992 MCLs. TPH elevated above background. Although the standard of 80 was exceeded one time in the 1989 sampling program (81 mg/kg) the concentration is below the 1991 State standard (100 mg/kg)
Contaminant Migration	Some Barium noted 200 ft downgradient
Contaminant Persistence	Associated with sediments. Site more than 15 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

South Harrison

Location and Drilling Characteristics

Latitude: 70°25′29.31" *Longitude*: 151°43′52.48"

Location: T. 12 N., R. 2 E., Sec. 6 NW 1/4, Umiat Meridian

Depth: *11,290 ft* *Drilled:* 11/21/76 - 2/8/77

Description

South Harrison Test Well No. 1 (plate 20A) is about 130 mi southeast of Barrow. The wellsite was seeded and (or) fertilized in 1978, 1980, and 1981. An airstrip, directly to the west of the wellsite, was constructed of sand, but is no longer usable because of differential settlement. No previous water-quality data are available. The site was visited in 1989 but not in 1990.

Drilling Pad: A thick pad was used. The pad, berms, and the airstrip were constructed using mostly sandy materials excavated from the reserve pit and a borrow site near the mouth of the Kalikpik River along the edge of Harrison Bay about 7 mi northwest of the wellsite. The pad was graded and recontoured and the reserve pit was backfilled. Some ponding of water was noted on the northwestern corner of the pad.

Reserve and Flare Pits: The pits were backfilled with thawed sand but subsequent differential settlement has left ponded water in parts of the sand fill to a depth of about 2 ft in 1987. Water flows into the pits through breaches on the eastern berm and flows out of the pits through breaches on the northern and western berms.

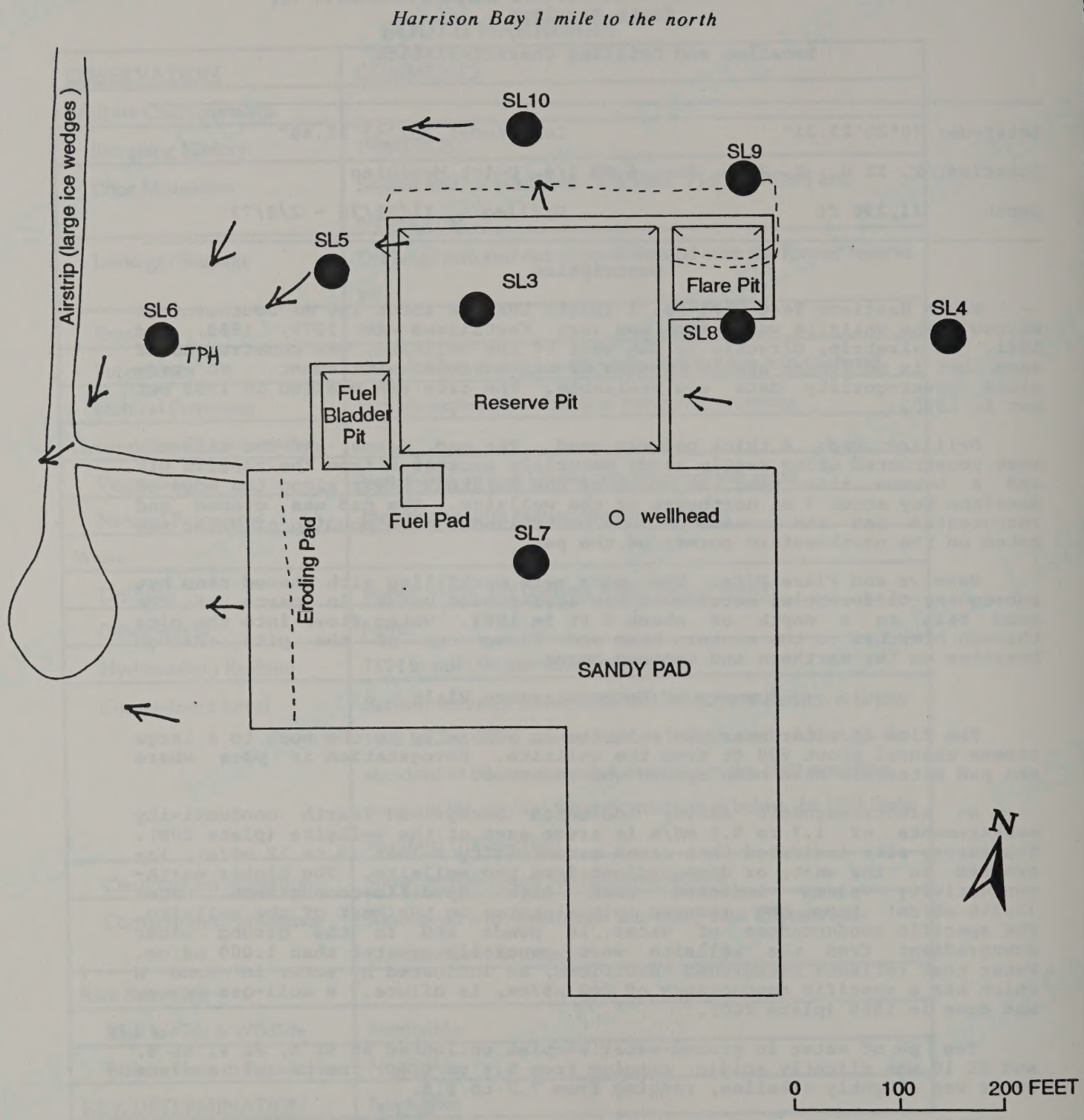
Summary of Reconnaissance Visit

The flow of water near the wellsite is generally to the west to a large stream channel about 600 ft from the wellsite. Revegetation is poor where the pad materials have been spread and reworked.

An electromagnetic survey indicated background earth conductivity measurements of 1.7 to 5.6 mS/m in areas east of the wellsite (plate 20B). The survey also indicated that earth conductivity values (9 to 12 mS/m) increased to the west, or downgradient from the wellsite. The higher earth-conductivity values indicate that high specific-conductance water (1,310 µS/cm) from the reserve pit migrates to the west of the wellsite. The specific conductances of water in ponds and in the ground water downgradient from the wellsite were generally greater than 1,000 µS/cm. Water that reflects background conditions, as indicated by water in Pond H which has a specific conductance of 202 µS/cm, is dilute. A soil-gas survey was done in 1989 (plate 20C).

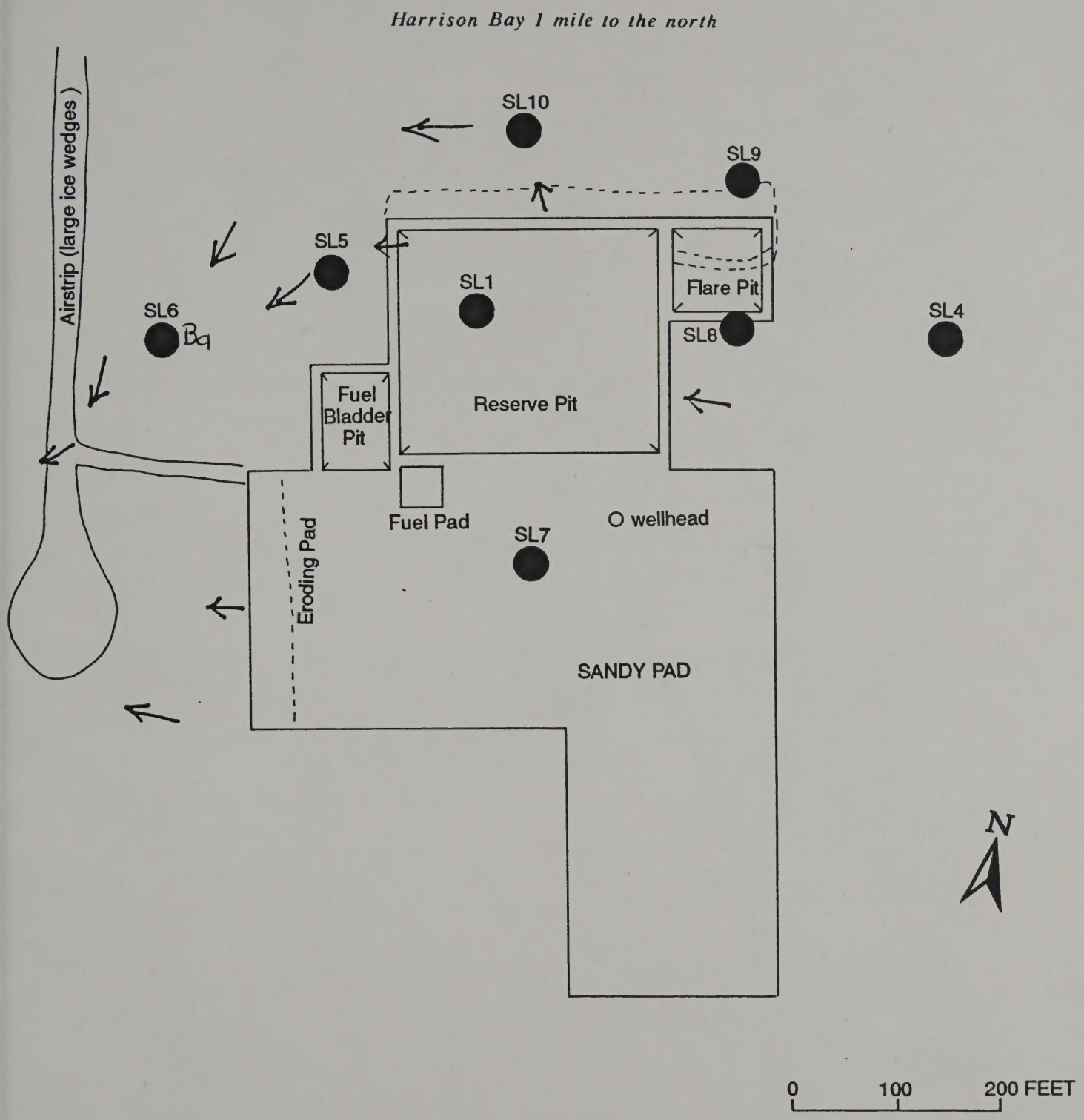
The pH of water in ground-water samples collected at SL 5, SL 6, SL 8, and SL 10 was slightly acidic, ranging from 5.4 to 6.6. The pH of surface water was slightly alkaline, ranging from 7.2 to 8.5.

TPH concentrations of 81 and 56 mg/kg were detected in soil samples collected at SL 6 and SL 9. TPH concentrations of 1.7 and 1.1 mg/L were detected in water samples collected at SL 5 and SL 6. The concentration of barium in water at SL 6 (1.6 mg/L) exceeded the MCL. Phenols were detected in water samples collected at SL 5 and SL 6, but the total concentration was less than 0.5 mg/L.



South Harrison, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



South Harrison, 1989

Locations of water samples and constituents having concentrations above criteria levels

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Schindler, J.F.; Smith, P.D.J.
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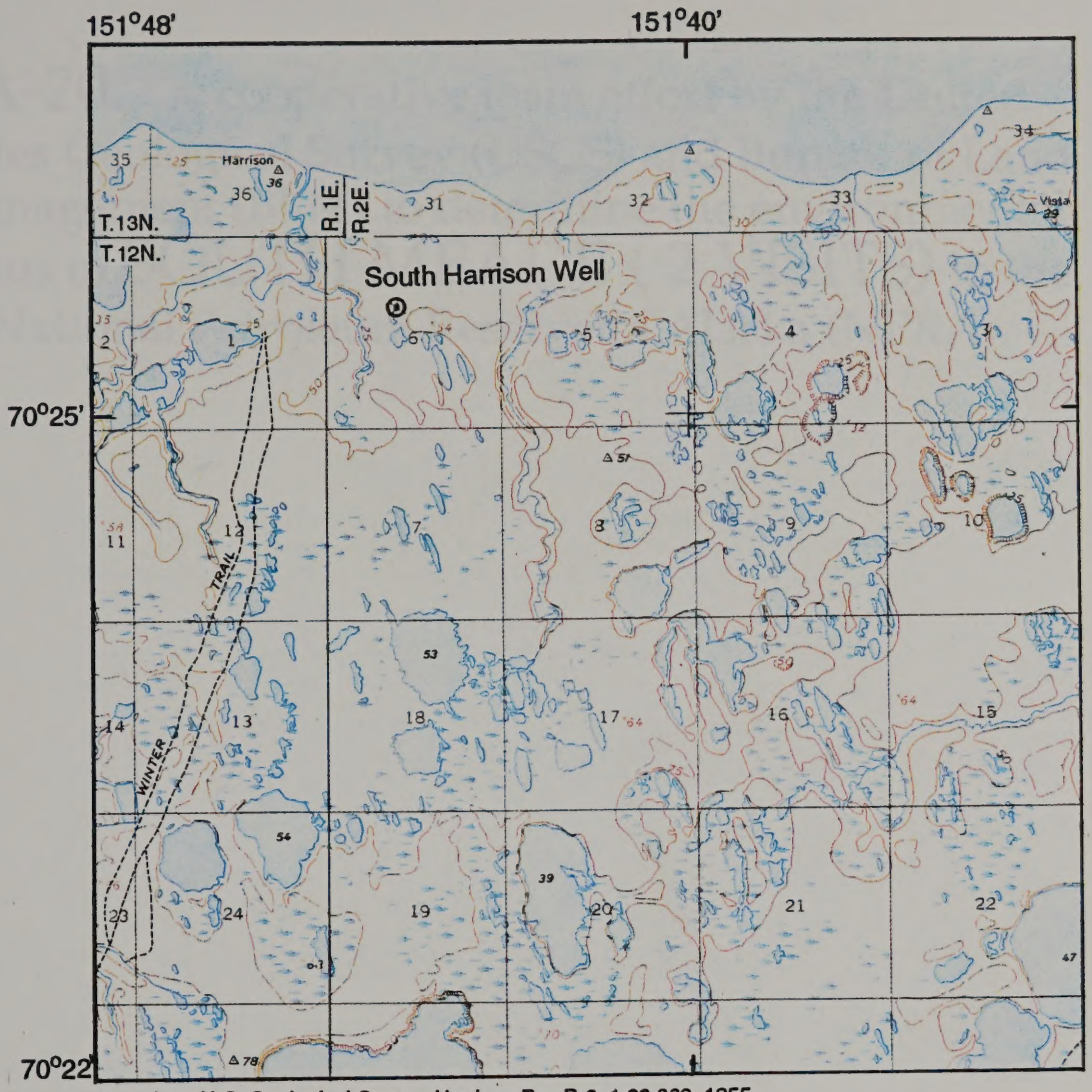
1983

08-06-89 BLM 1:4000 S. HARRISON 2-3-3



Base from U.S. Geological Survey, Harrison Bay B-3, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of South Harrison well.

A-20. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of SOUTH MEADE (2 VISITS) in the National Petroleum Reserve in Alaska (NPRA).

20. WELLSITE RISK DETERMINATION
SOUTH MEADE

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1983,1989,1990(USGS), 1984(NUERA)
Prior Mitigation	Backfilled and contoured. Seeded and Fertilized 1979,1980,1981,1982
Leakage/Seepage	Ponded area formed above former reserve pit draining on east side
Erosion	Wind erosion of entire drilling site
Subsidence	Pit has subsided after backfilling and covered with 2 feet of water
Natural Processes	Wind erosion on drill site-very sandy site
General Site Characteristics	
Vegetation	None/spotty
Natural Processes	Wind erosion of entire site
Waste	
Drilling	Buried and covered with 2 feet of water. TPH and BTEX elevated above background. Chromium elevated above MCL
Other Solids	Exposed liner
Hydrocarbon Residue	TPH elevated above background in the pit and adjacent to the pit
Contaminant Level	TPH elevated above background on pad, in pit and adjacent areas. Flair pit was actively used. Chromium elevated above MCL. Barium elevated above MCL
Contaminant Migration	Some limited migration of Chromium, Barium and TPH
Contaminant Persistence	Associated with sediments. Site more than 13 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

South Meade

Location and Drilling Characteristics

Latitude: 70°36′53.92" *Longitude*: 156°53′23.60"

Location: T. 15 N., R. 19 W., Sec. 31 NW 1/4, Umiat Meridian

Depth: 9,945 ft *Drilled*: 2/7/78 - 5/17/78 and 12/4/78 - 1/22/79

Description

South Meade Test Well No. 1 (plate 21A) is located about 50 mi south of Barrow and was drilled during two winter seasons. The wellsite is between two arms of a lake. Site rehabilitation in 1979 and 1980 included cutting of pilings, recontouring of pad, and backfilling of the reserve pit. The pad and berms were seeded and fertilized in 1979, 1980, and 1982. Fertilizer was also applied in 1981. Water-quality samples were collected by USGS in August 1983 and by the Nuera Reclamation Company in July 1984. The site was visited in 1989 and 1990.

PREVIOUS WATER-QUALITY DATA
[USGS, unpublished data on file in the District Office of the U.S. Geological Survey, Anchorage, Alaska; Nuera, Nuera Reclamation Company]

Date	Temperature (°C)	pH	Specific conductance (µS/cm)	Reference
		Reserve pit		
8/15/83	3.5	8.4	2,800	USGS (1984)
7/12/84	10.0-11.0	8.3-8.5	1,550-1,600	Nuera (1986, p. 55-56)
		Southeast arm of lake near reserve pit		
8/15/83	4.0	6.1	108	USGS (1984)
7/12/84	11.5	7.3	41	Nuera (1986, p. 56)

Drilling Pad: A thick pad was constructed using local sand. No off-site materials were needed. A liner was used under the drilling rig and fuel pit. Extensive wind erosion of the sandy material has occurred, and parts of the fuel pit plastic liner and tops of pilings have been uncovered.

Reserve and Flare Pits: The pits were backfilled, but subsequent settlement has allowed water to accumulate to a depth of about 2 ft in the reserve pit. Berms appear to be generally intact, except that overflow has occurred throughout the length of the east side. The water surface in the reserve pit was about 4 ft higher than the lake in 1989. Oil was reported bubbling to the surface within the reserve pit in 1982. A low area of the berm between the flare and reserve pits might allow exchange of water when water levels are high. The JP-5 used to pack the well between periods of drilling was flared in the flare pit. Algal growth was observed in water on August 15, 1983.

Adjacent Areas: In 1984, an oily residue and sheen were observed in areas adjacent to the east side of the reserve pit. Sand eroded from the pad is being deposited on the downwind (northeastern) side.

Summary of Reconnaissance Visits

No vegetation is growing in the areas of wind erosion, which is virtually the entire disturbed area. The electromagnetic survey in 1989 indicated background earth conductivity values of 3 to 5 mS/m everywhere except in the area of overflow on the eastern side of the reserve pit (plate 21B). Earth conductivities in the overflow area were 7 to 9 mS/m.

The survey with the organic vapor analyzer in 1989 indicated elevated soil-gas readings at SL 9 near the fuel pit (plate 21C). A sample collected at SL 9 contained 1,100 mg/kg of TPH and 7.9 mg/kg of BTEX compounds. A second soil-gas survey in 1990 was used to select sites SL 9A and SL 9B (plate 21F) for collection of soil samples.

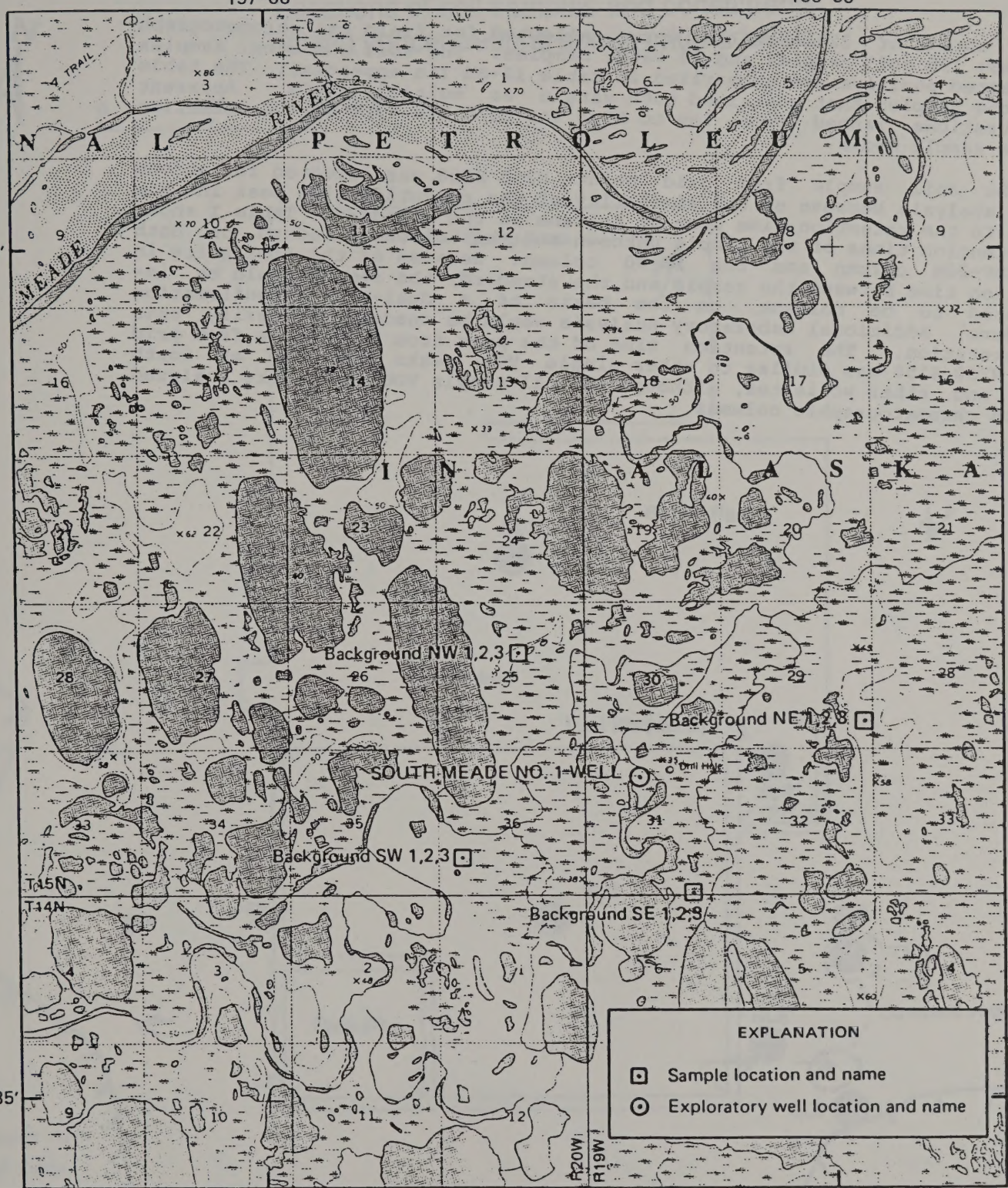
In 1989, the specific conductance of water in the reserve pit was 1,210 µS/cm. Water in Ponds A and B downgradient from the wellsite was similar to water in the reserve pit, with specific conductances of 1,330 and 1,320 µS/cm, respectively. The specific conductances of water in ponds upgradient from the wellsite generally ranged from 300 to 500 µS/cm.

The pH of all water samples collected ranged from 5.9 to 8.5. Most were near neutral in both 1989 and 1990 (plate 21D).

In 1989, the concentrations of BTEX in soil were above the PMCLs at SL 9 and SL 3. The concentration of barium in water exceeded the MCL (2.0 mg/L) at SL 5. Chromium in water exceeded the MCL at SL 1, SL 5, SL 6, and SL 8. Lead in water exceeded the MCL at SL 1, SL 5, and SL 8. Concentrations of TPH were 1,100 mg/kg at SL 9 and 200 mg/kg at SL 8.

South Meade was one of two sites chosen for detailed sampling in a grid pattern in 1990. A grid with spacing of 50 ft was laid out oriented to the configuration of the reserve pit (plate 21E). Samples were collected on the basis of the grid lines at 50-foot intervals closer to the reserve pit and at 100-foot intervals farther away from it. The grid sampling confirmed concentrations that exceed the MCLs for barium in water, chromium in water, and TPH in sediment. Most of these high concentrations occurred in the area of and downgradient from the east berm, where overflow has occurred. In May 1990, the water on top of the ice in the reserve pit (SL B) had chromium concentrations of 0.13 mg/L and 0.37 mg/L, which are above the MCL of 0.05 mg/L. When sampled in July 1990, the chromium concentration at SL 1 was 1.1 mg/L.

South Meade was one of the wellsites chosen for analysis of background concentrations of TPH (fig. 14). TPH in soils exceeded the background value of 80 mg/kg in 32 samples in 1990. Most of these samples were in the area of overflow on the east side of the reserve pit. The remaining samples were at the rig site, near the flare pit, in the fuel pit area, in the reserve pit, and in the east arm of the lake near the wellsite. In May 1990, the concentration of BTEX exceeded the PMCL at two locations in the reserve pit: at the center and closer to the wellhead, and on the berm between the wellhead and the reserve pit. Also, the sample from the east arm of the lake had a concentration of orthophosphate as phosphorus of 0.79 mg/L. USEPA (1986b) has established a maximum concentration for phosphorus of 0.10 mg/L as a goal for the prevention of plant nuisances in streams.



Base from U.S. Geological Survey, Meade River C-2, 1:63,360, 1955

0 1 2 3 4 MILES

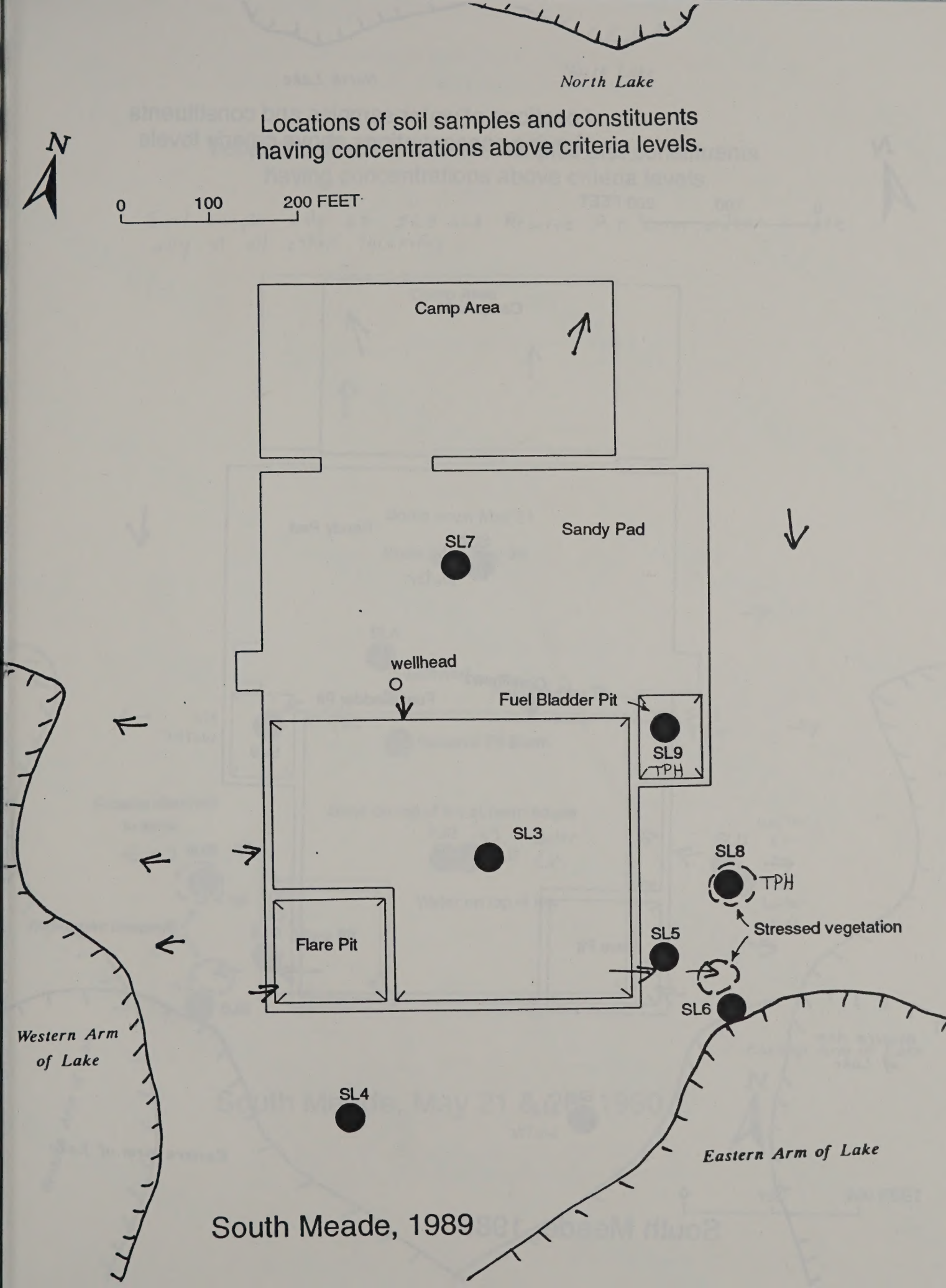
0 1 2 3 4 5 KILOMETERS

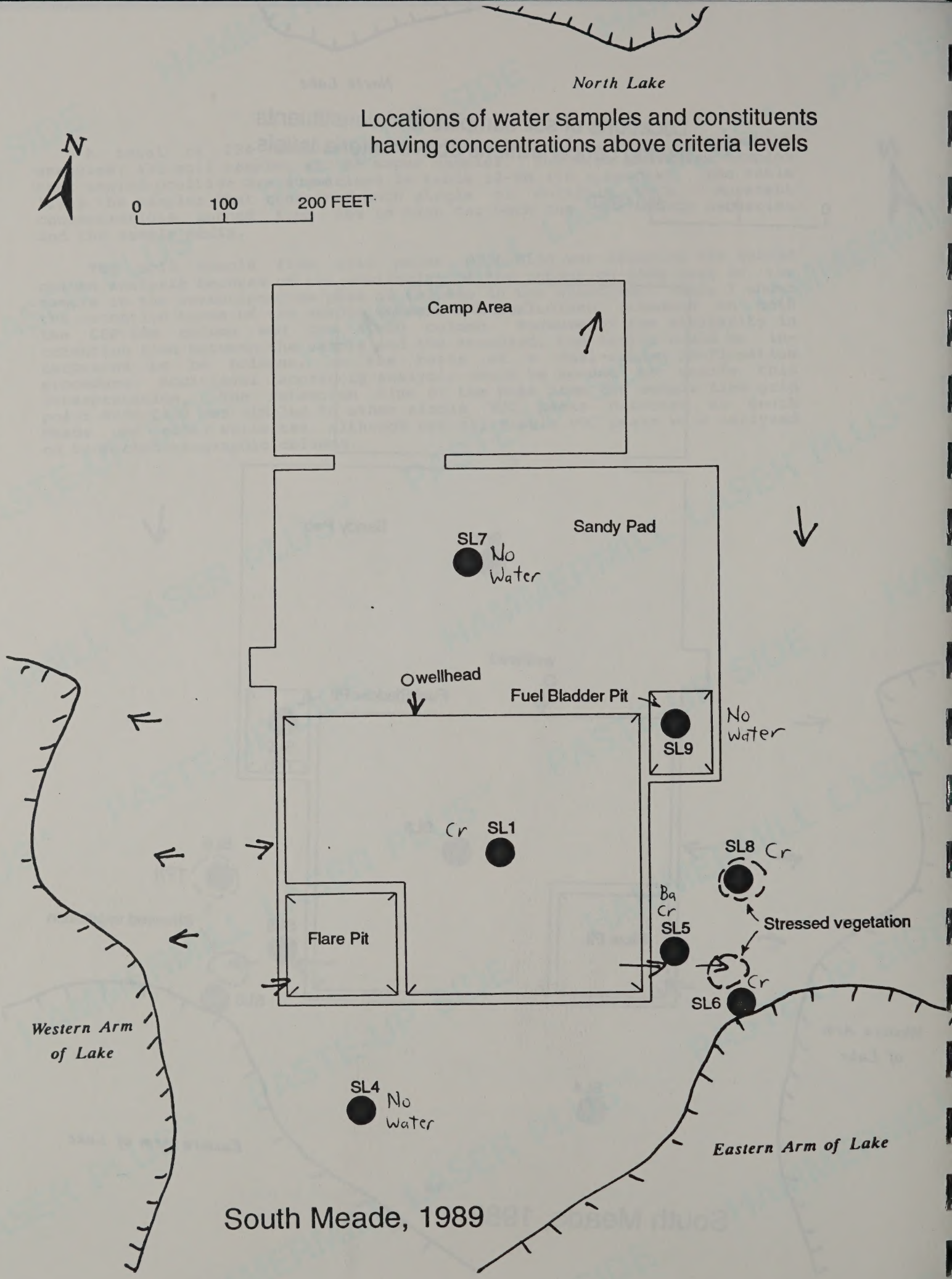
CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Figure 14.--South Meade No. 1 well and background sample locations.

A total of 224 samples were collected for field gas chromatograph analyses: 135 soil samples and 89 water samples. The soil and water samples that tested positive are summarized in table 12-SM (in appendix). The table lists the samples that contained both single or multiple VOCs. Apparent concentrations ranged from low to high for both the type of VOC detection and the sample media.

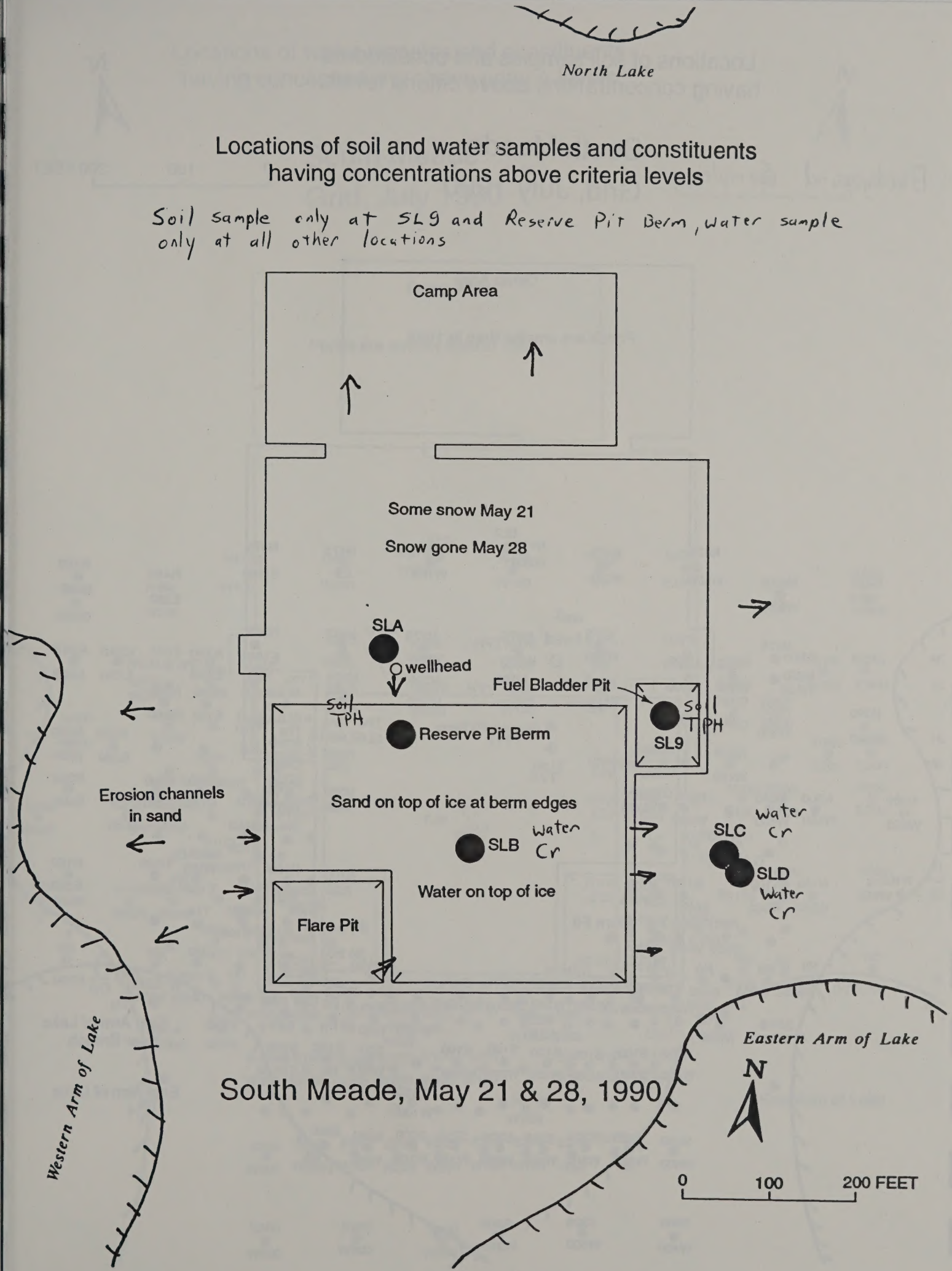
The soil sample from grid point N250 E150 was selected for second column analysis because of the similarity of the retention-time peak in the sample to the retention-time peak of toluene in the standard. Table I shows the retention times of the sample unknown and the toluene standard on both the CSP-20M column and the SE-30 column. Because of the similarity in retention time between the sample and the standard, the sample could be interpreted to be toluene, on the basis of a dual-column confirmation procedure. Additional laboratory analysis would be needed to verify this interpretation. The retention time of the peak from the sample from grid point N250 E150 was similar to other single VOC peaks detected at South Meade and other wellsites, although not all single VOC peaks were analyzed on both chromatographic columns.


North Lake
Locations of soil samples and constituents having concentrations above criteria levels.
N
0
100
200 FEET
Camp Area
Sandy Pad
SL7
wellhead
Fuel Bladder Pit
SL9
TPH
SL3
SL8
TPH
Stressed vegetation
SL5
Flare Pit
SL6
Western Arm of Lake
SL4
Eastern Arm of Lake
South Meade, 1989


North Lake
Locations of water samples and constituents having concentrations above criteria levels
N
0
100
200 FEET
Camp Area
Sandy Pad
SL7
No Water
wellhead
Fuel Bladder Pit
SL9
No water
Cr
SL1
SL8
Cr
Ba
Cr
SL5
Stressed vegetation
Cr
SL6
Flare Pit
Western Arm of Lake
SL4
No water
Eastern Arm of Lake
South Meade, 1989

Locations of soil and water samples and constituents having concentrations above criteria levels

Soil sample only at SL9 and Reserve Pit Berm, water sample only at all other locations

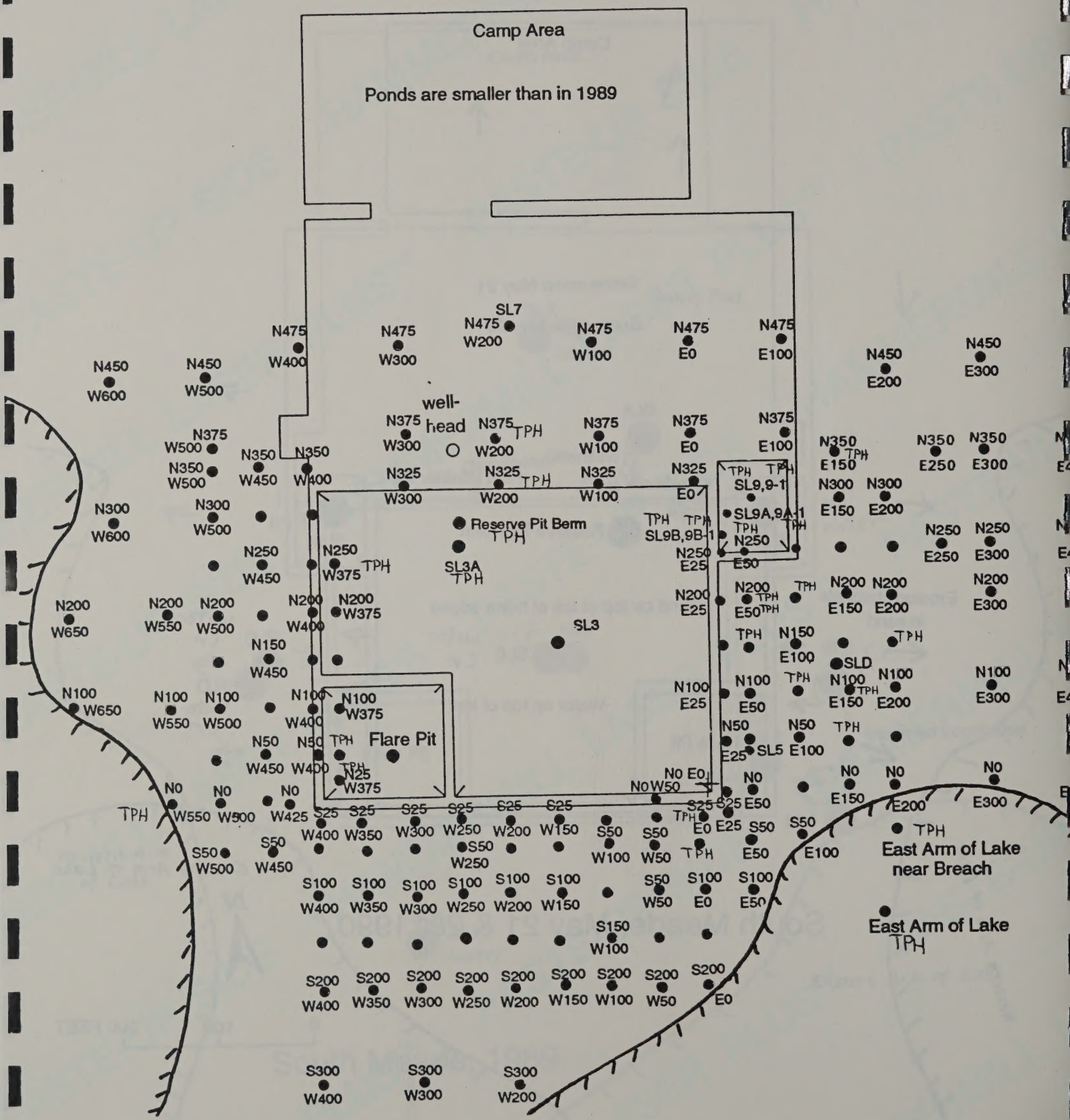


South Meade, May 21 & 28, 1990

Locations of soil samples and constituents having concentrations above criteria levels.

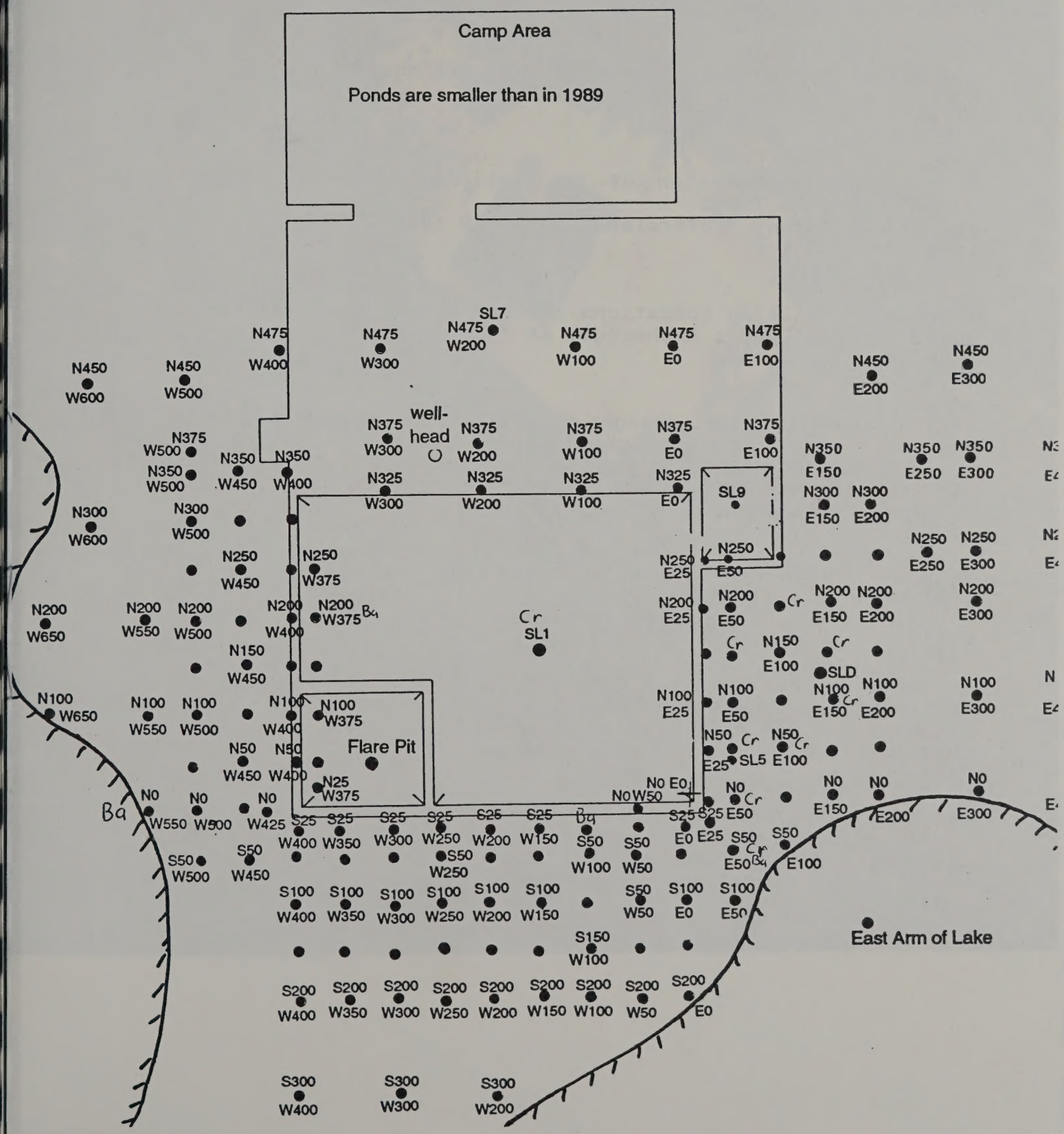
South Meade Grid, July 1990

Background Samples



Locations of water samples and constituents having concentrations above criteria levels

South Meade Grid, July 1990



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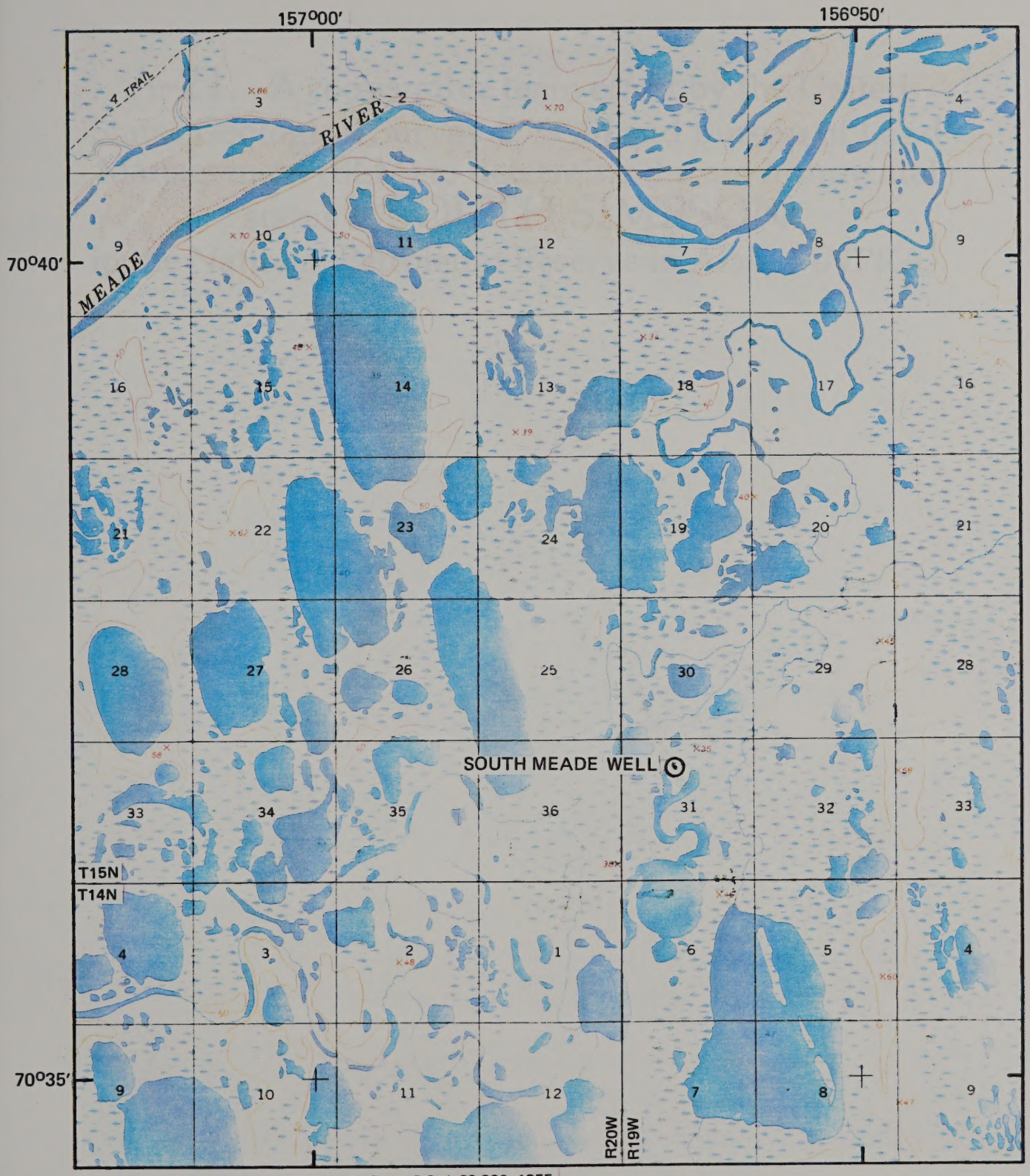
08-05-89 BLM 1:3200
S. MEADE 9-1-2



Base from U.S. Geological Survey, Meade River C-2, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of South Meade well.

A-21. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of SOUTH SIMPSON in the National Petroleum Reserve in Alaska (NPRA).

21. WELLSITE RISK DETERMINATION
SOUTH SIMPSON

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1978,1981 and 1982. Backfilled and recontoured
Leakage/Seepage	Natural surface drainage being reestablished
Erosion	None
Subsidence	Pit subsided through melting of underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Sparse on pad
Natural Processes	Surface expression of natural polygons returning
Waste	
Drilling	Waste buried with pad material. Covered by 3 1/2 feet of water
Other Solids	None observed
Hydrocarbon Residue	Elevated TPH above background at one sample location near the pad
Contaminant Level	Only one sample showed elevated TPH
Contaminant Migration	TPH measured downgradient
Contaminant Persistence	Associated with sediments. Site more than 15 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

South Simpson

Location and Drilling Characteristics

Latitude: 70°48′24.75" *Longitude:* 154°58′54.61"

Location: T. 17 N., R. 12 W., Sec. 22 SE 1/4, Umiat Meridian

Depth: 8,795 ft *Drilled*: 3/9/77 - 4/30/77

Description

South Simpson Test Well No. 1 (plate 22A) is about 52 mi southeast of Barrow. The ground is about 5 ft above sea level. The site was seeded and (or) fertilized in 1978, 1981, and 1982. No water-quality data were available prior to 1989. The site was visited in 1989, but not in 1990.

Drilling Pad: A thick pad was used. The materials for construction of the pad and berms were well-drained sand taken from a high sand bank of the Piasuk River about 5 mi east of the site. After drilling was completed, the pad was partially recontoured.

Reserve and Flare Pits: The pits were backfilled with thawed sand. Berm heights were reduced during recontouring efforts, and subsequent thermokarst subsidence has created multiple routes for water to flow through the pits. The northern berm is entirely under water.

Summary of Reconnaissance Visit

Water in the reserve pit is unusually clear and less than 4 ft deep. As a result, bottom features are evident in the aerial photographs of the wellsite. Regional flow is toward the north, but the gradient is less than 0.5 ft in a distance of 2,000 ft. Revegetation in this wet coastal wellsite consists primarily of scattered mosses. Revegetation by planted seeds is poor to moderate.

The electromagnetic survey around the perimeter of the wellsite indicated that background earth conductivity values at this site were in the range of 5 to 8 mS/m (plate 22B). Earth-conductivity readings on the pad were slightly higher, ranging from 8 to 10 mS/m. The soil-gas survey indicated no elevated concentrations of soil gas (plate 22C).

The specific conductance of a water sample collected at SL 7 on the pad was 2,930 µS/cm, and specific conductance of a water sample from Pond D on the pad was 1,370 µS/cm. Specific conductances of water samples collected at other locations at the wellsite ranged from 159 to 862 µS/cm.

The pH of water samples collected at the wellsite was neutral to slightly basic, ranging from 6.8 to 8.8 pH. All the samples having values below 7.2 were from ground water.

The concentration of TPH in the soil sample at SL 5 was 250 mg/kg, above background of 80 mg/kg.

Tulageak

Location and Drilling Characteristics

Latitude: 71°11'21.62" *Longitude*: 155°44'00.82"

Location: T. 21 N., R. 14 W., Sec. 7 NW 1/4, Umiat Meridian

Depth: 4,015 ft *Drilled*: 2/26/81 - 3/23/81

Description

Tulageak Test Well No. 1 (plate 23A) is about 24 mi east-southeast of Barrow, about 0.25 mi south of Tulageak Point and 2 mi north of Reindeer Lake. The area near the wellsite is relatively flat and poorly drained coastal tundra with indistinct surface expression polygon development. This location was flooded by seawater during a storm in 1963. The drilling mud used at this wellsite had a high calcium chloride content (20,000-40,000 mg/L Cl and 15,000-25,000 mg/L Ca). The site was seeded and (or) fertilized in 1981 and 1982. Water-quality data (metal analyses) were collected by Tetra Tech (1983) during March 1981 and by the Nuera Reclamation Company in July 1984. The site was visited in 1989 and 1990.

The water-quality data presented below represent the range in values determined in water-depth profiles at two locations in the reserve pit.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/5/84	1.0 - 5.0 °C	8.1-8.3	1,100-1,110 µS/cm	Nuera Reclamation Company (1984, p. 63-64)

Drilling Pad: A thin pad was used. Materials used in construction of the pad were excavated from the reserve pit. During the first spring thaw after drilling, the pad subsided to an irregular shape.

Reserve and Flare Pits: The pits are open, not backfilled. The berm has subsided, and large breaches allow flow into the reserve pit on the eastern side and out of the pit on the western side. Water in the pit was about 4.5 ft deep in July 1984.

Summary of Reconnaissance Visits

Flow of surface water at this wellsite is generally away from the coastal berm east of the wellsite and toward a tidal inlet on the west. The highest topography at the wellsite is the camp pad, at which revegetation has been most successful. Revegetation throughout the wellsite is more effective than at most other wellsites.

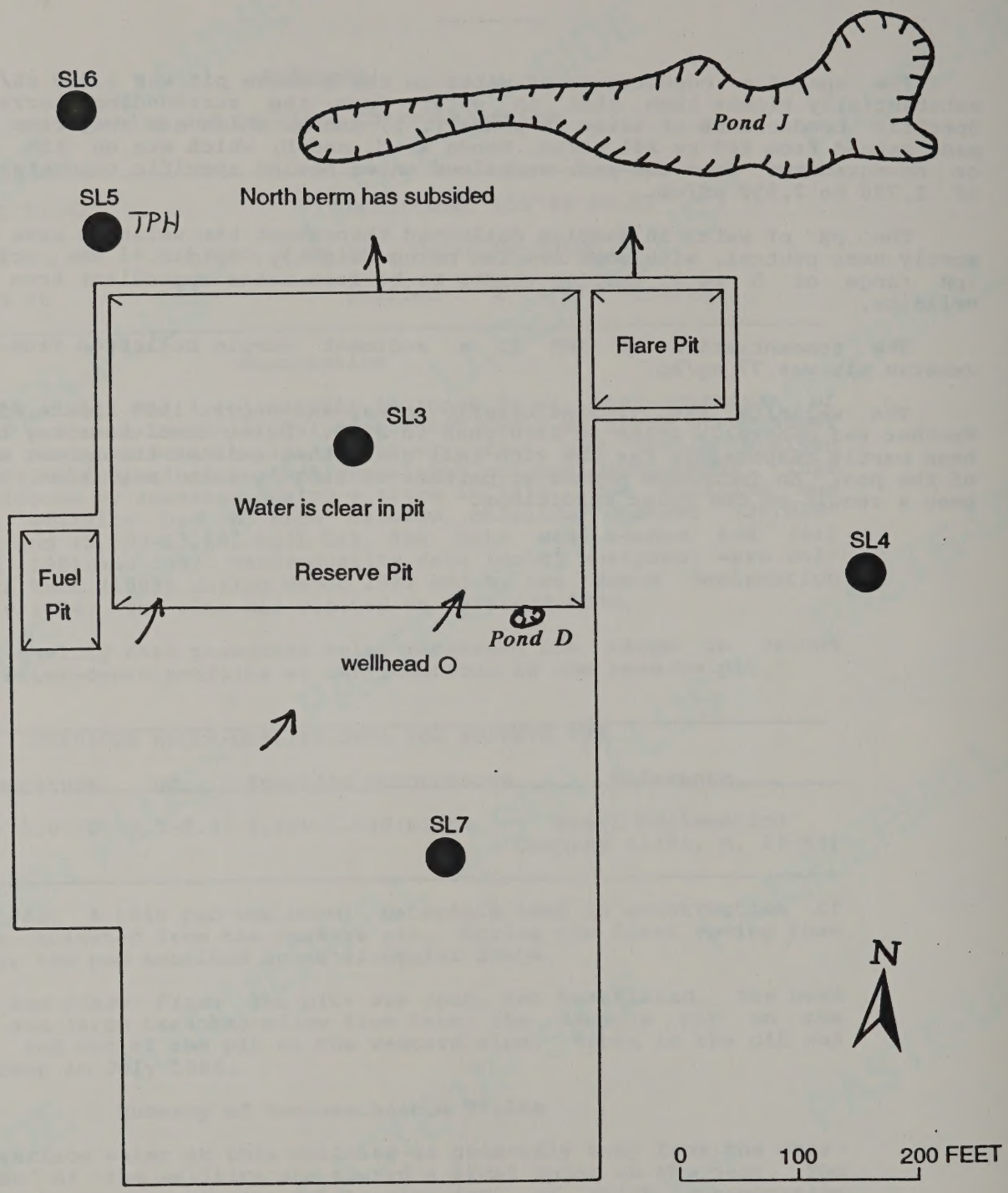
The entire area has been inundated by storm tides. Salt-water exposure has resulted in high earth conductivities throughout the area. No electromagnetic anomalies were detected (plate 23B). A soil-gas survey was not done.

The specific conductance of water in the reserve pit was 3,980 µS/cm, substantially higher than that in water from the surrounding terrain. Specific conductance of water in ponds F, L, and M, which are away from the pad, ranged from 603 to 861 µS/cm. Ponds A, J, and H, which are on the pad or downgradient from the pad, contained water having specific conductances of 1,730 to 2,330 µS/cm.

The pH of water in samples collected throughout the wellsite area was mostly near neutral, with some samples being slightly acidic. The acidic (pH range of 5 to 7) samples tended to be from areas upgradient from the wellsite.

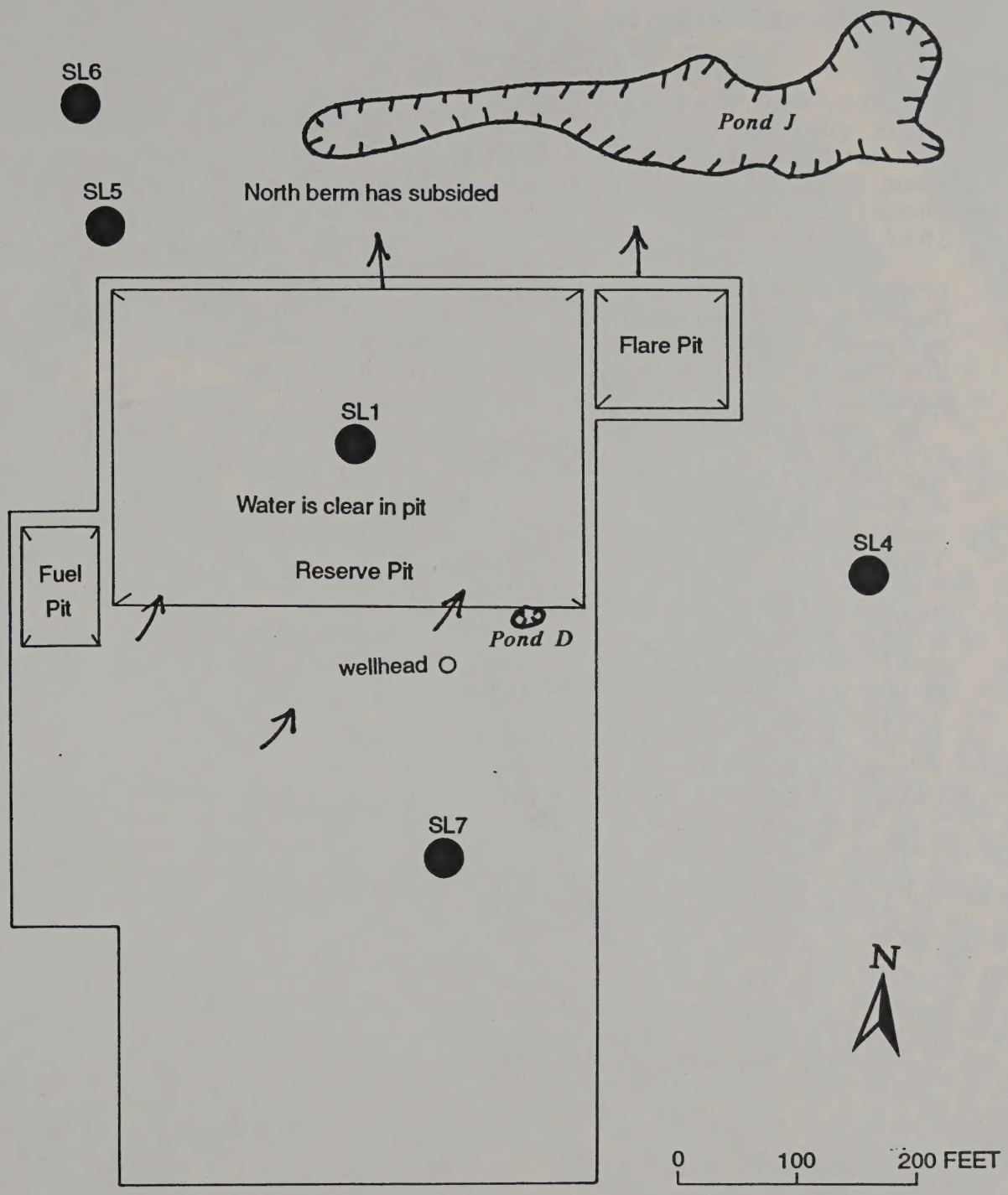
The concentration of TPH in a sediment sample collected from the reserve pit was 77 mg/kg.

The wellsite was visited briefly in May and August 1990 (plate 23C). Weather was generally drier in 1990 than in 1989. Drier conditions may have been partly responsible for the rich tall grass that existed throughout much of the pad. An increased number of patches of salt crusts may also have been a result of the drier conditions.



South Simpson, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



South Simpson, 1989

Locations of water samples and constituents having concentrations above criteria levels

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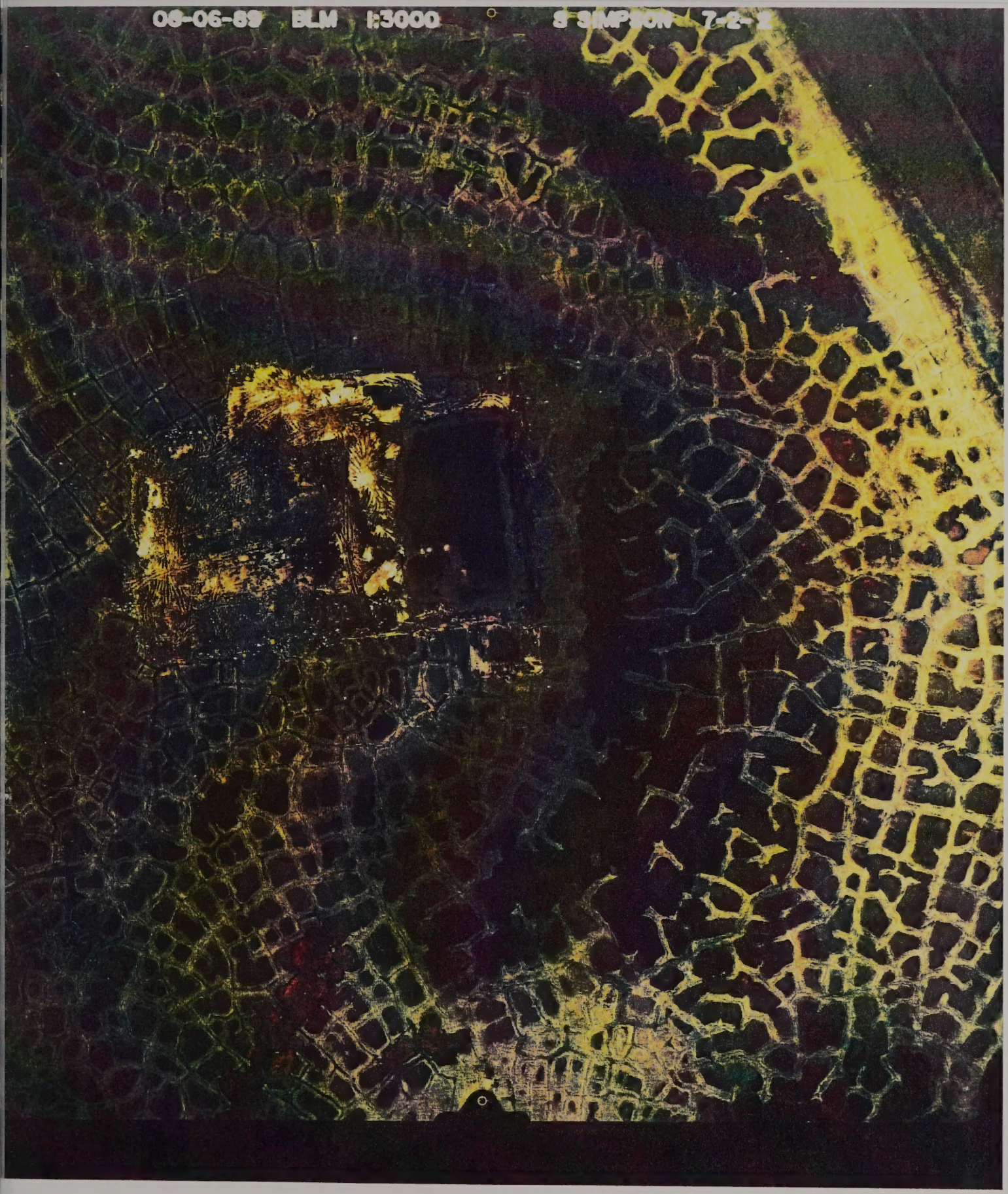
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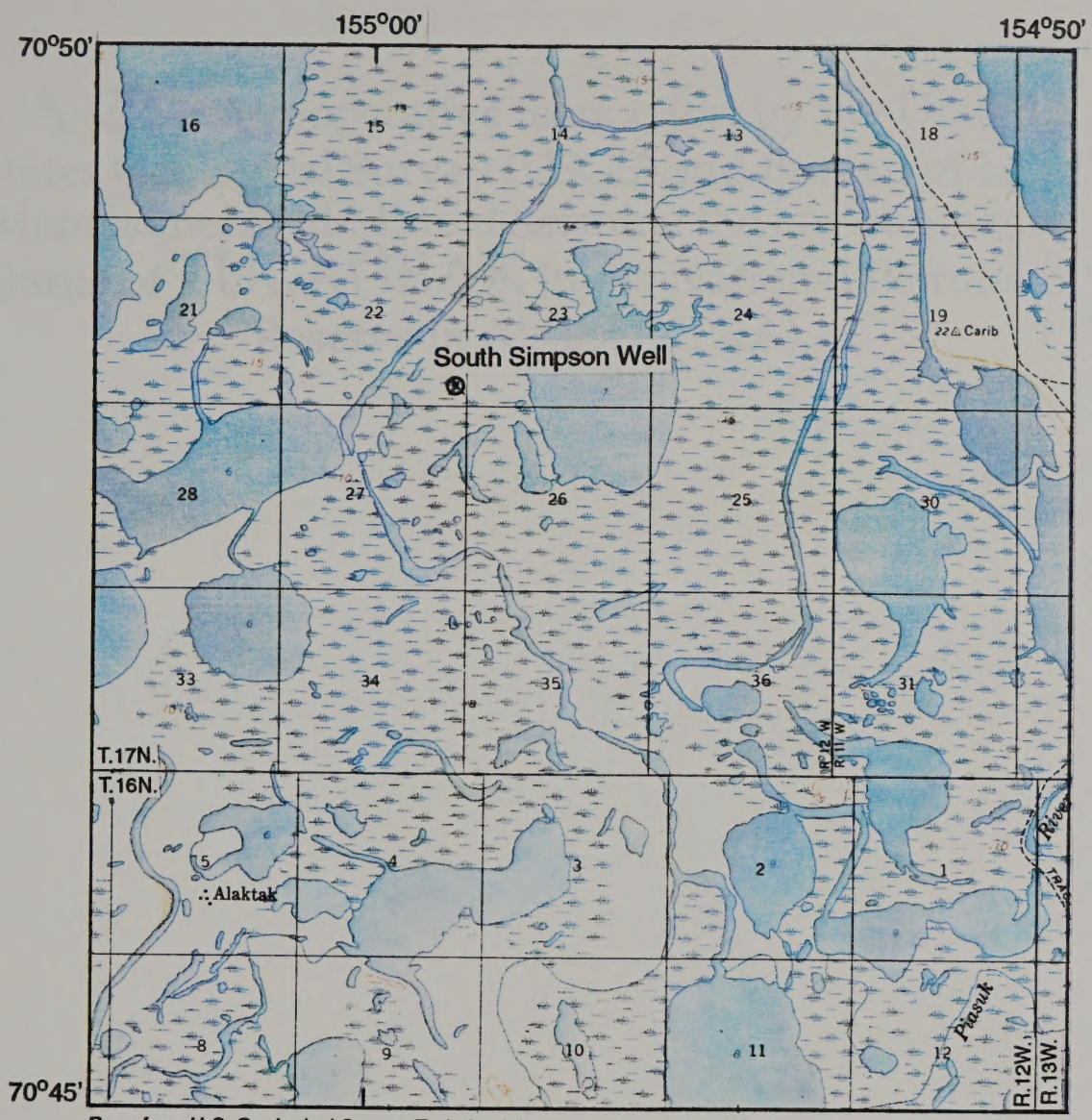


Base from U.S. Geological Survey, Teshekpuk D-4, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

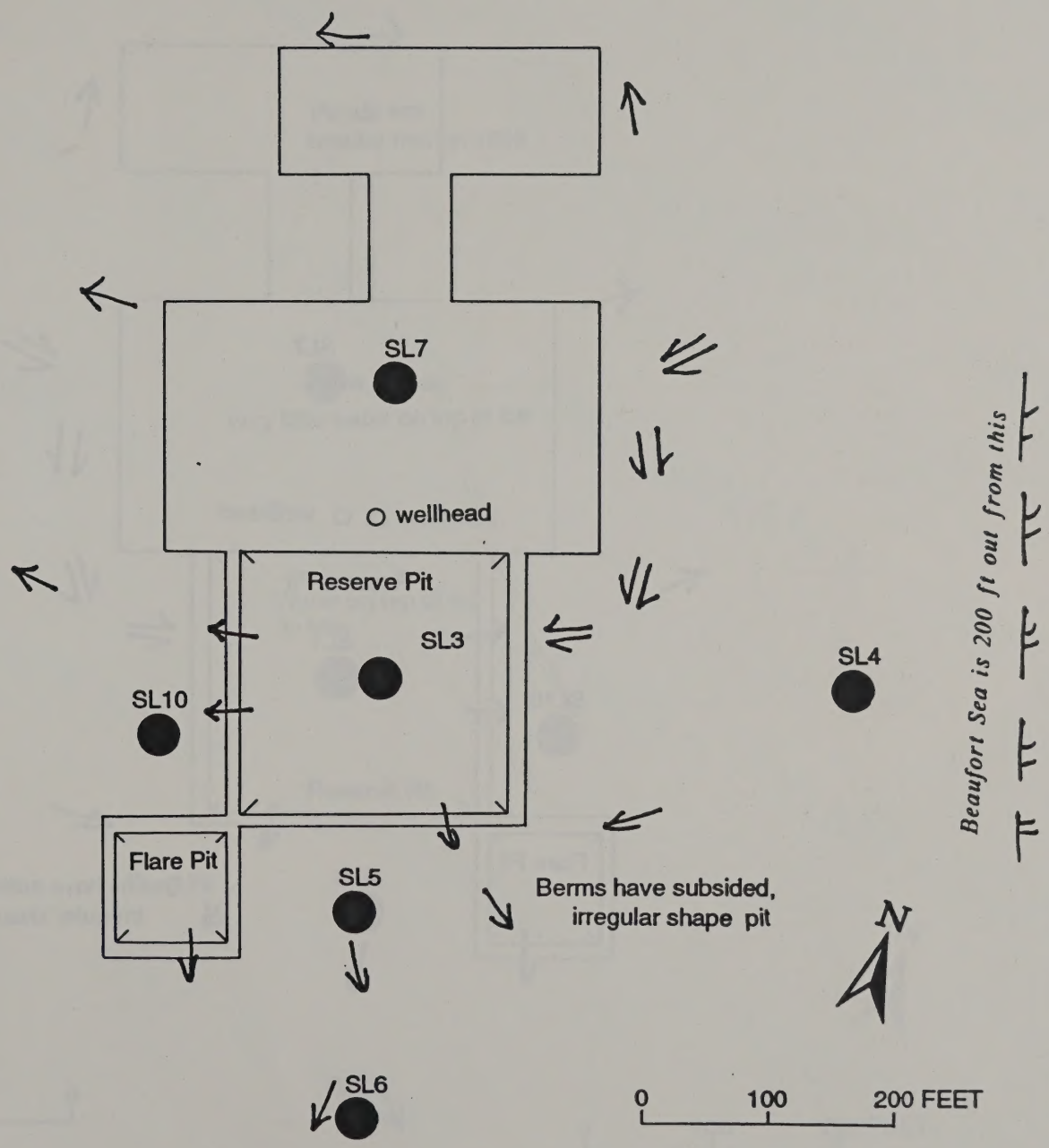
CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of South Simpson well.

A-22. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of TULAGEAK in the National Petroleum Reserve in Alaska (NPRA).

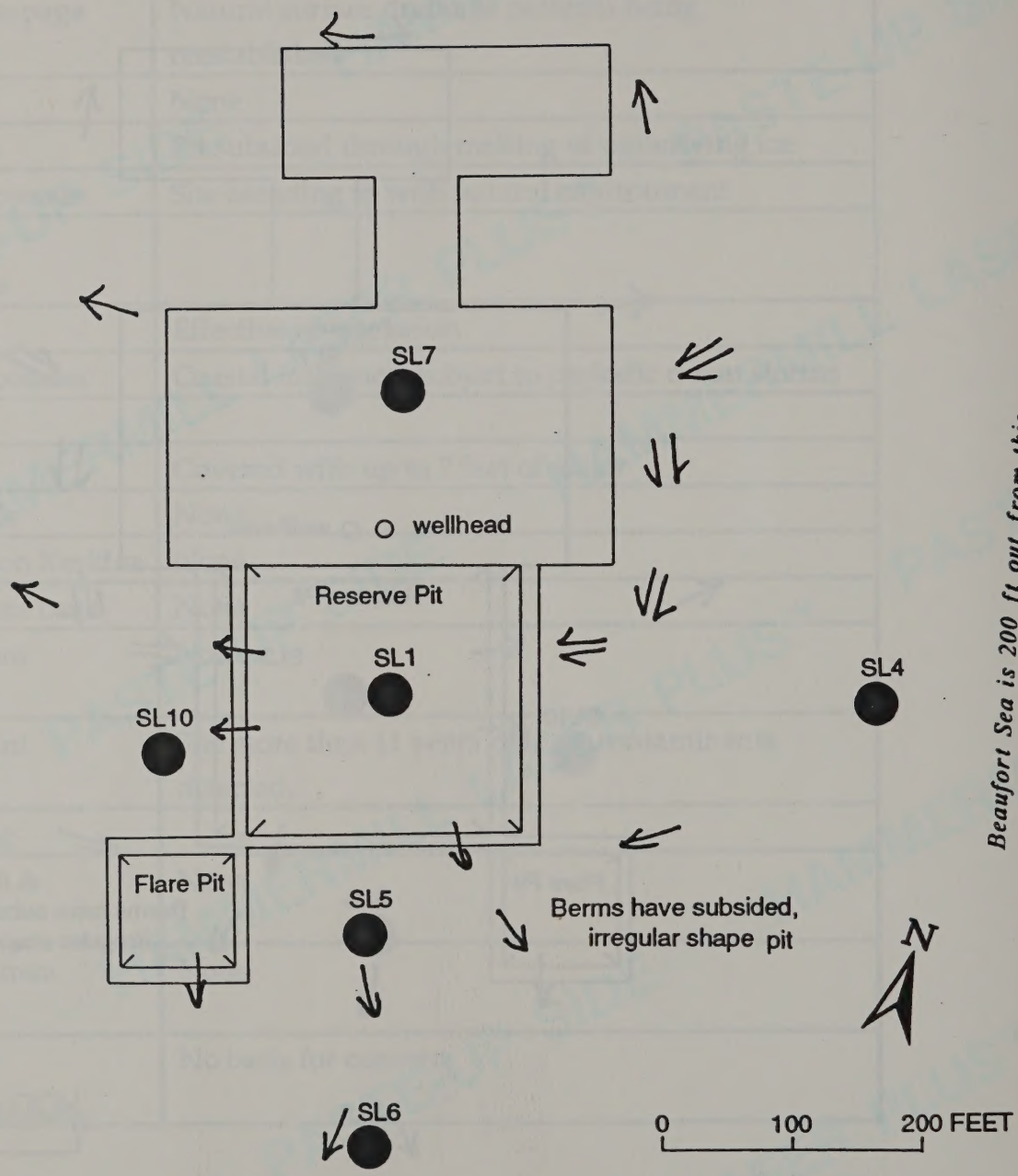
22. WELLSITE RISK DETERMINATION
TULAGEAK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1981(TETRA TECH), 1984 (NUERA), 1989(USGS)
Prior Mitigation	Seeded and/or Fertilized in 1981,1982
Leakage/Seepage	Natural surface drainage patterns being reestablished
Erosion	None
Subsidence	Pit subsided through melting of underlying ice
Natural Processes	Site blending in with natural environment
General Site Characteristics	
Vegetation	Effective revegetation
Natural Processes	Coastal influence; subject to periodic ocean storms
Waste	
Drilling	Covered with up to 7 feet of water
Other Solids	None
Hydrocarbon Residue	None
Contaminant Level	None
Contaminant Migration	None
Contaminant Persistence	Site more than 11 years old. no contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	None
Risk to Human Population	None
RISK DETERMINATION	No basis for concern



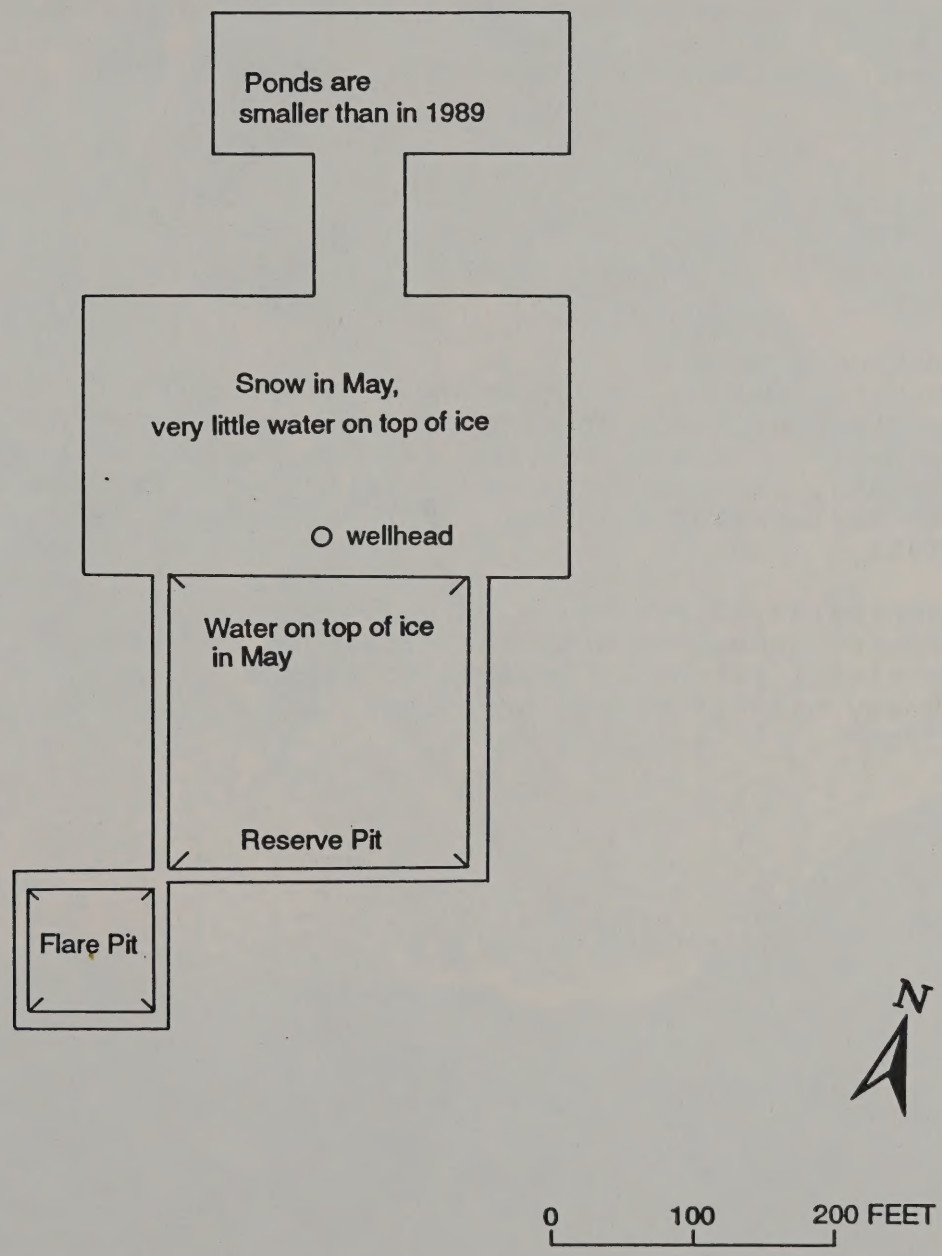
Tulageak, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



Locations of water samples and constituents having concentrations above criteria levels

Tulageak, 1989



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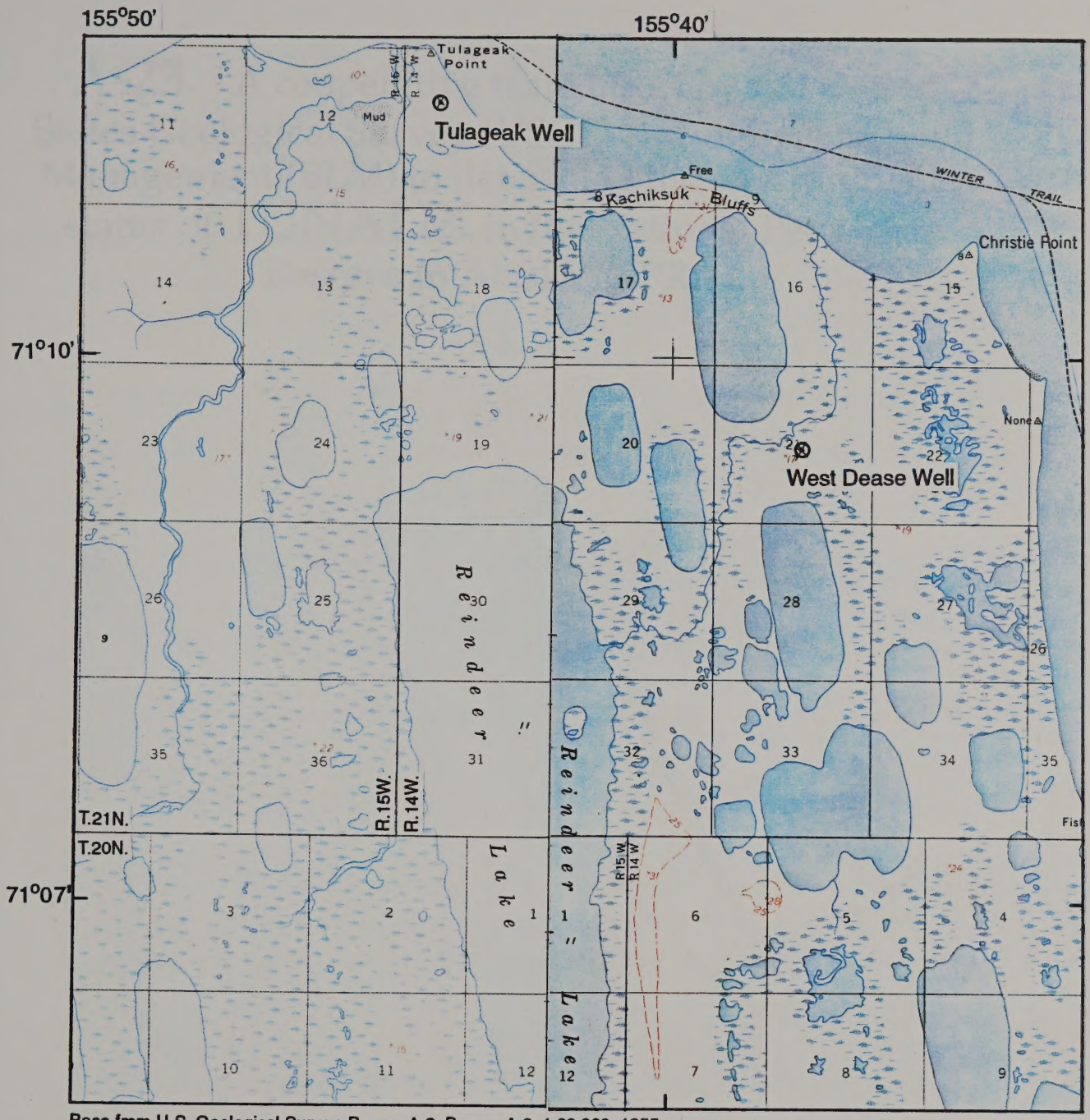
TULAGEAK 27-2-2



Base from U.S. Geological Survey, Barrow A-2, Barrow A-3, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of West Dease well and Tulageak well.

A-23. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of TUNALIK in the National Petroleum Reserve in Alaska (NPRA).

23. WELLSITE RISK DETERMINATION
TUNALIK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA),1983,1989,1990(USGS)
Prior Mitigation	Seeded and/or Fertilized 1980,1981,1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Minimal subsidence
Natural Processes	Natural drainage patterns being reestablished on uninsulated areas of pad
General Site Characteristics	
Vegetation	Low quality of vegetation
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Covered by water up to 6 1/2 feet in reserve pit. TPH, BTEX and Chromium are elevated above background in flare and reserve pits Chromium is highly elevated above MCL
Other Solids	Exposed liner and Insulation
Hydrocarbon Residue	Elevated TPH in pits and elevated adjacent to pits. BTEX highly elevated above background in flare pit
Contaminant Level	TPH and BTEX are highly elevated above background levels but confined to flair pits. Barium, Chromium and Fluoride elevated above MCL. Vinyl Chloride elevated above MCL
Contaminant Migration	Insignificant although concentrations around the MCL levels were measured
Contaminant Persistence	TPH and BTEX associated with sediments in pits. Chromium and Barium levels drop rapidly adjacent to the pits. Site is more than 12 years old.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible-nearby airstrip used infrequently
RISK DETERMINATION	Negligible

Tunalik

Location and Drilling Characteristics

Latitude: 70°12′21.453" *Longitude*: 161°04′09.159"

Location: T. 10 N., R 36 W., Sec. 20 SE 1/4, Umiat Meridian

Depth: 20,335 ft *Drilled* 11/10/78 - 1/7/80.

Description

Tunalik Test Well No. 1 (plate 24A) is located about 40 mi southwest of Wainwright, 120 mi southwest of Barrow, and about 0.5 mi west of Ongorakvik River. The wellsite is about 6 mi inland from Kasegaluk Lagoon near Icy Cape on the Chukchi Sea. The wellsite is located in a flat tundra area of low-centered polygons. Soils in the area that underlie an organic mat are generally fine- to medium-grained ice-rich sands. The drilling pad, airstrip, and connecting road were constructed from February to May 1978. Drilling took place during 1978 and 1980 from an all-season pad. A sandy gravel airstrip is located about 0.7 mi southwest of the wellsite and is connected to the wellsite with a road. No major streams or lakes are nearby (within about 0.25 mi). High pressure gas encountered at depths of about 12,550 ft and 14,725 ft created severe drilling problems. Heavy-weighted drilling muds were used to control high-pressure gas flows. The wellsite was fertilized and seeded in 1980 and 1982, and was fertilized in 1981. The ground of the drilling pad is about 85 ft above sea level. Water-quality data were collected by Northern Testing Laboratories (NTL) in June 1982, by USGS in August 1983, and by the Nuera Reclamation Company in July 1984. This site was visited in 1989 and 1990.

PREVIOUS WATER-QUALITY DATA

[NTL, Northern Testing Laboratories; USGS, unpublished data on file in the District Office of the U.S. Geological Survey, Anchorage, Alaska; Nuera, Nuera Reclamation Company]

Date	Temperature (°C)	pH	Specific conductance (µS/cm)	Reference
			Reserve pit	
6/28/82	6.5-7.2	7.8	1,300-1,400	NTL (1982)
8/24/83	3.5	8.6	3,000	USGS (1984)
7/15/84	10.3-14.0	8.4-8.5	1,500-1,650	Nuera (1986, p. 142-143)
			Flare pit	
7/15/84	16.8	9.0	115	Nuera (1986, p. 143)

Drilling Pad: A thick gravel pad was constructed with mineral materials, styrofoam insulation, and a plastic cover. Mineral materials for the pad and berms were from a borrow site 4.5 mi west of the wellsite.

Reserve, Flare, and Fuel Pits: The pits were left open, not back-filled. Wave action and thermokarst action have eroded the berms extensively. The berms between the fuel pit and the reserve pit, between the reserve pit and the flare pit, and between the pits and the surrounding tundra are all breached. The depth of water in the reserve pit was 5 ft in July 1984, and 6.5 ft in July 1989. An odor similar to that of diesel fuel was noted in the vicinity of the flare pit in 1983, and rising bubbles of oil were observed in 1984. Water draining along the road enters the fuel pit. Extensive erosion by wave action and thermokarst action has eroded the berms and allowed water to escape.

Summary of Reconnaissance Visits

The dominant direction of flow is eastward toward Ongorakvik River. A few grasses have established themselves, but most of the new ground cover consists of moss.

The electromagnetic survey showed background values of 4 to 5 mS/m on the northern, western, and southern sides of the wellsite (plate 24B). Higher values in the range of 6 to 12 mS/m near and downgradient from the outlet breach indicate the direction of movement of higher specific-conductance water.

A soil-gas survey with the organic vapor analyzer in 1989 indicated one area of increased readings in the vicinity of the east breach and two smaller areas of elevated readings near the flare pit and on the southwestern corner of the pad (plate 24C). A sample was collected at SL 9 near the flare pit. In 1990, the survey was continued to obtain better definition of the areas of elevated soil-gas concentrations on the western side of the pad and near the flare pit (plate 24E). As a result of this survey, an additional sample at the southwest pad corner and 21 samples near the flare pit were collected.

In 1989, specific conductance of water in the reserve pit, 608 µS/cm, was low in comparison with water in other NPRA reserve pits, but was still significantly above background at this wellsite, as defined by specific conductance of water in Ponds G, K, and L. Water in these ponds has specific conductance values of less than 100 µS/cm. Water in the reserve pit has been sampled repeatedly since 1982 for specific conductance:

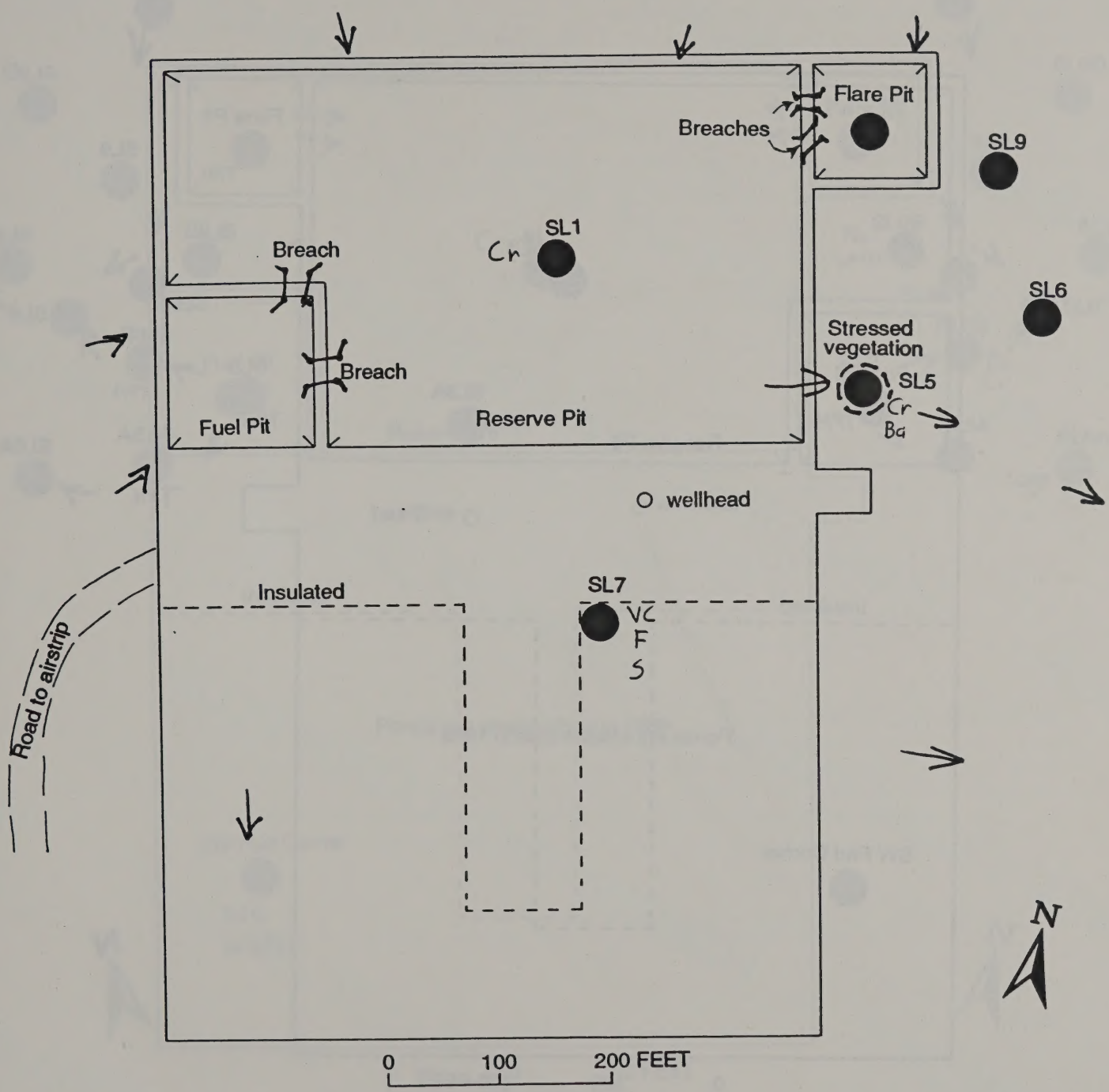
Specific conductance (µS/cm)	Year
1,300-1,400	1982
3,000	1983
1,500-1,650	1984
608	1989
577	1990

It therefore appears that the reserve pit water is becoming significantly more dilute as time passes.

The range of pH is one of the largest of the NPRA wellsites: it ranged from 4.4 to 9.6 (plates 24A and 24D).

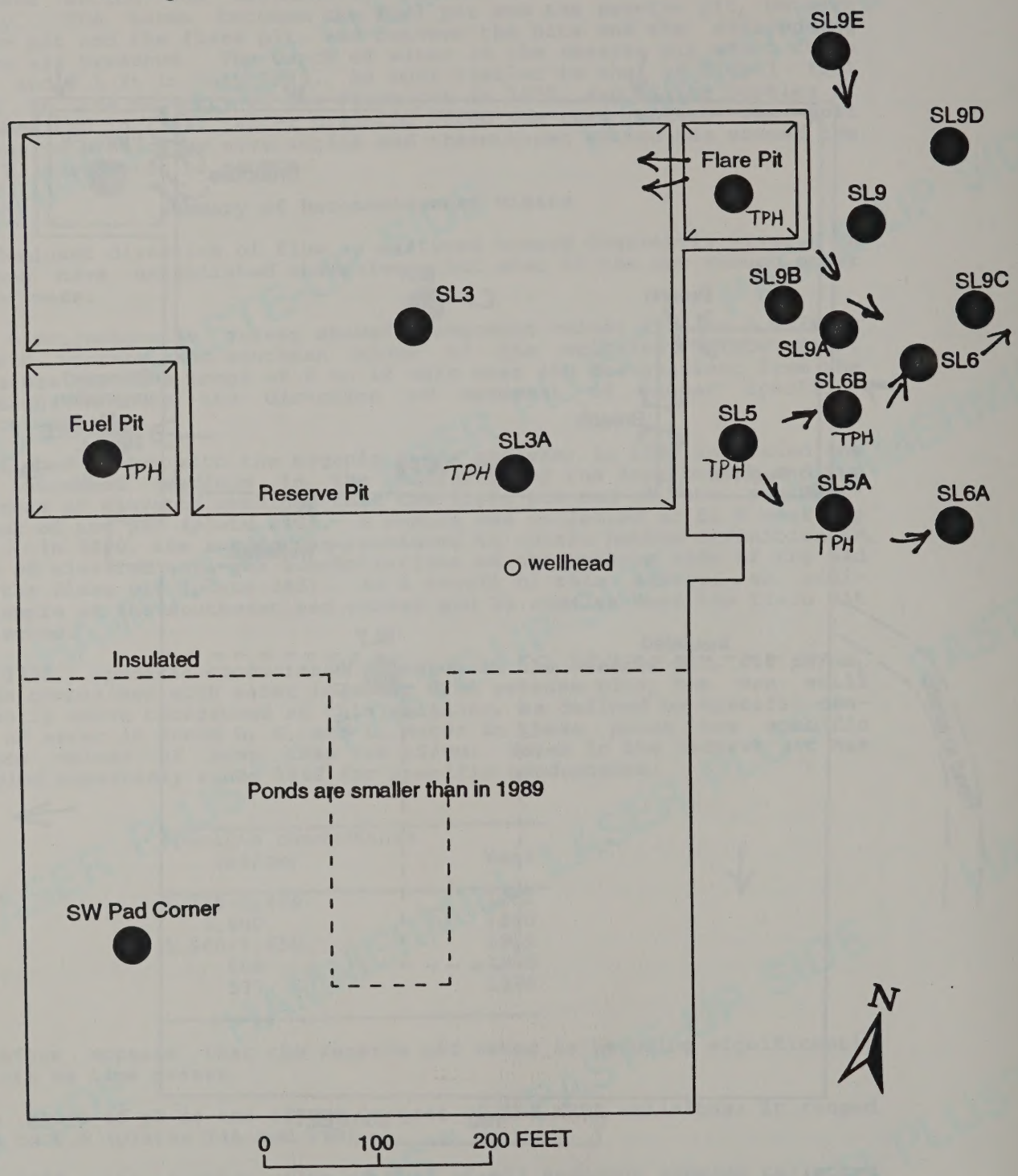
In 1989, the highest value of BTEX of all sediment samples collected for the year was 396 mg/kg in the flare pit. Most of this was present as xylene, but ethylbenzene and toluene were also present. In 1990, the concentration of BTEX in a flare pit sample was 1,560 mg/kg. These high BTEX concentrations were accompanied by a high concentration of TPH,

Locations of water samples and constituents having concentrations above criteria levels



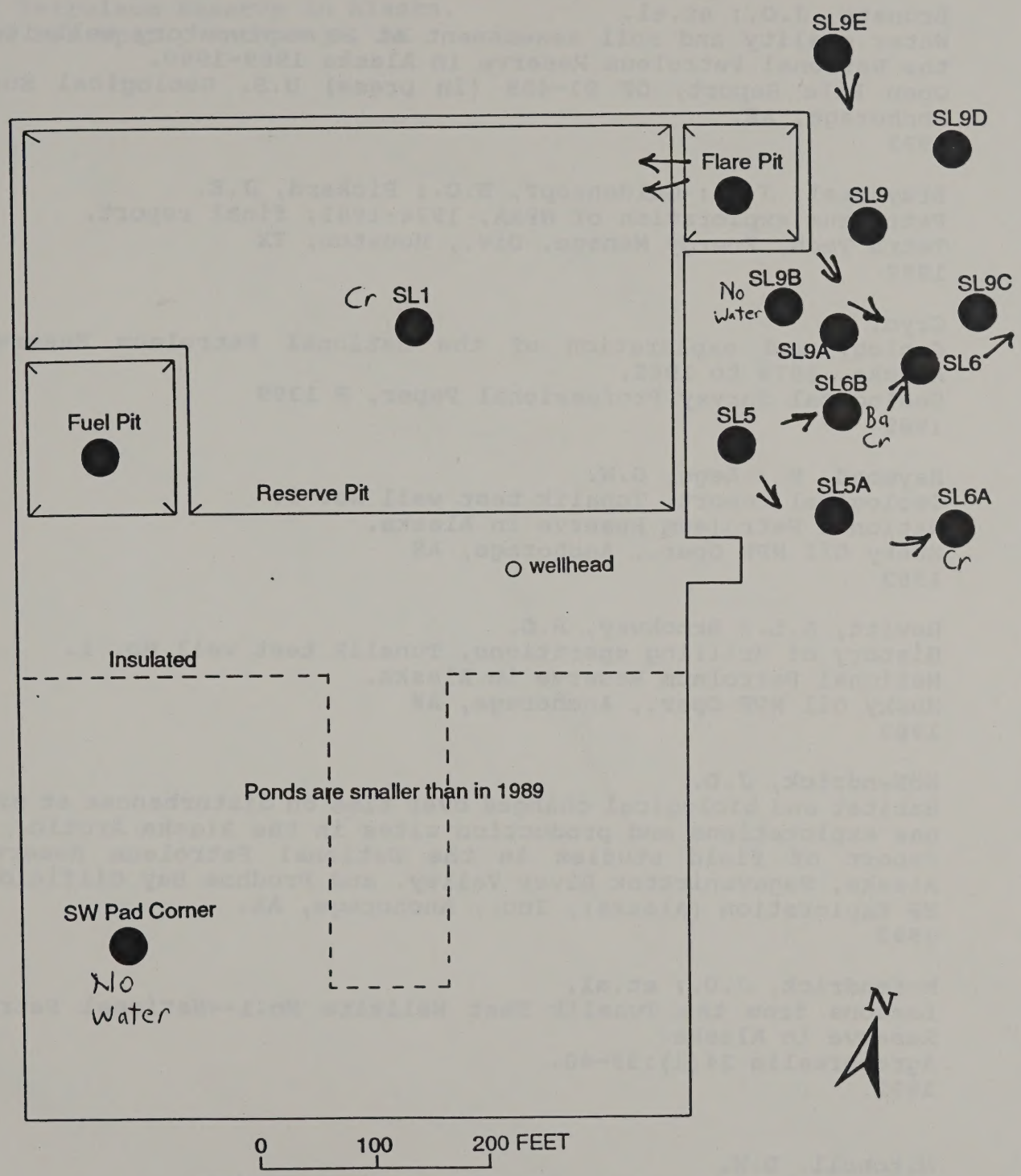
Tunalik, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



Tunalik, July 29, 1990

Locations of water samples and constituents having concentrations above criteria levels



Tunalik, July 29, 1990

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1983

08-07-89 BLM 1:3600
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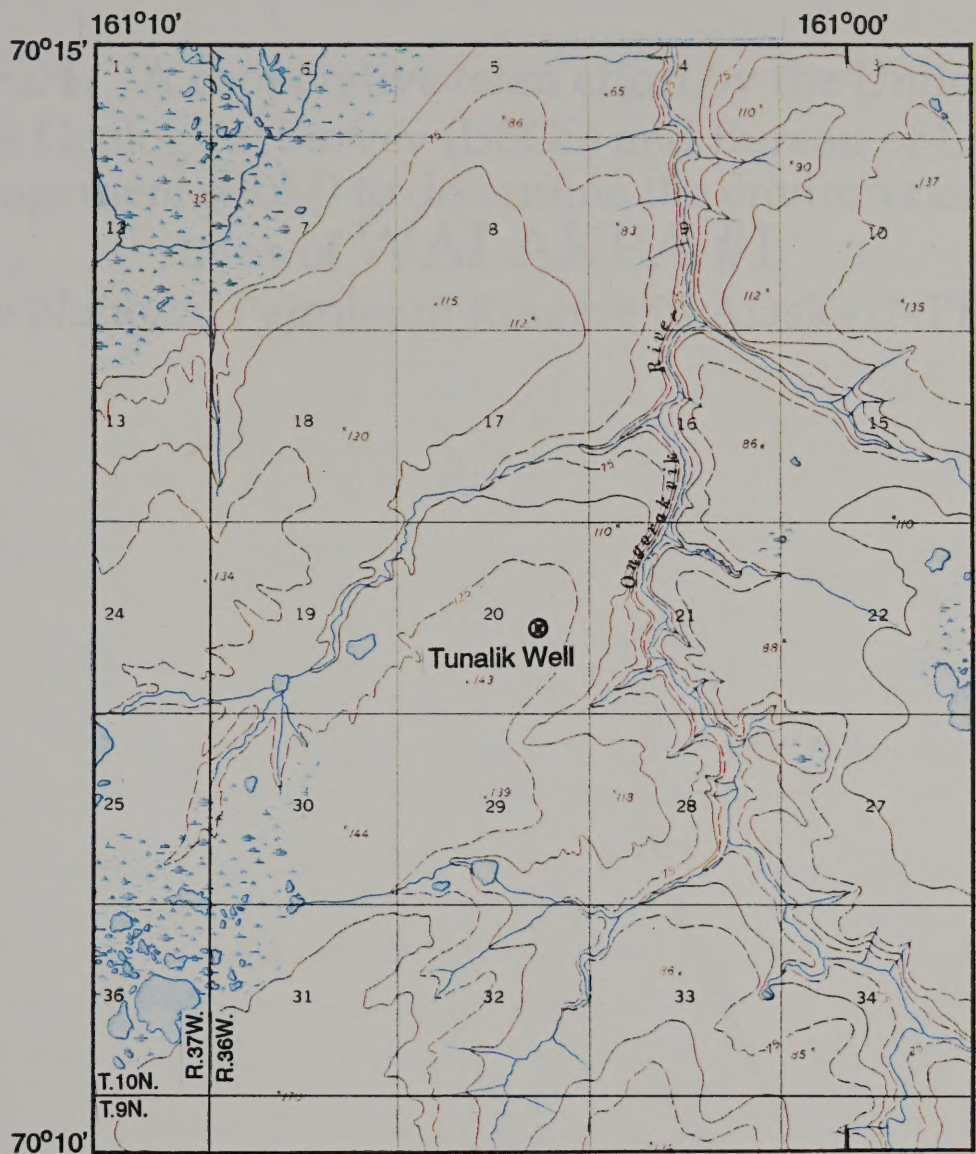


Base from U.S. Geological Survey, Wainwright A-4, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of Tunalik well.

A-24. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of WALAKPA #1 in the National Petroleum Reserve in Alaska (NPRA).

24. WELLSITE RISK DETERMINATION
WALAKPA #1

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA),1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1980,1981,1982
Leakage/Seepage	Natural surface drainage of water into and out of pit
Erosion	None
Subsidence	Pit subsided through melting underlying ice; pits were left open
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Sparse to moderate on pad
Natural Processes	Natural drainage patterns reestablished and blending in with area. 40 year old cat trail is prominent just South of wellsite
Waste	
Drilling	Covered by 6 feet of water
Other Solids	None
Hydrocarbon Residue	None
Contaminant Level	None
Contaminant Migration	None
Contaminant Persistence	Associated with sediments. Site more than 12 years old.
Risk Screening	
Risk to Fish & Wildlife	None
Risk to Human Population	None
RISK DETERMINATION	No basis for concern

Walakpa No.1

Location and Drilling Characteristics

Latitude: 71°05'57.63" *Longitude* 156°53'03.79"

Location: T. 20 N., R. 19 W. Sec. 9, SE 1/4, Umiat Meridian

Depth: 3,666 ft *Drilled*: 12/25/79 - 2/7/80

Description

Walakpa Test Well No. 1 (plate 25A) is about 14 mi south of Barrow in relatively flat, polygonized tundra. The wellsite was seeded and fertilized in 1980, and fertilized again in 1981 and 1982. A water-quality sample was collected by the Nuera Reclamation Company in July 1984. The site was visited in 1989, but not in 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/3/84	8.5-9.0 °C	7.5-8.2	160-170 µS/cm	Nuera Reclamation Company (1986, p. 71-72)

Drilling Pad: Materials for the berms and the thin pad were excavated from the reserve pit. During spring thaws, the pad has subsided to an irregular shape.

Reserve and Flare Pits: The pits were left open, not backfilled. Water depth in the reserve pit was about 6 ft both in 1984 and 1989. The low berms around the pits have settled and eroded, allowing free exchange of water with the surrounding terrain.

Summary of Reconnaissance Visit

The wellsite is lightly vegetated, primarily by moss, not grasses. The wellsite area is very flat, less than 0.5 ft gradient per 1,000 ft in all directions. Regional flow is probably toward an unnamed creek to the west, but local flow can be in any direction, depending on local obstructions to flow.

An electromagnetic survey indicated that background values of earth conductivity were in the range of 7 to 8 mS/m (plate 25B). Slightly higher values, in the range of 11 to 13 mS/m, were recorded on the western and northern sides of the pit and the pad. Specific conductance of water in the pit was 1,120 µS/cm, well above the background values of less than 200 µS/cm, as indicated in distant or upgradient ponds.

A very brief soil-gas survey detected elevated readings at SL 9 (plate 25B). The sediment sample collected at this point contained oil and grease at a concentration of 240 mg/kg, but VOCs and TPH were not detected.

The pH of water in ponds near the pad and reserve pit was alkaline, with values of 8.5, 9.4, 8.3, and 7.9. Other ponds and most ground-water samples were acidic and dilute.

This wellsite had no constituents in excess of MCLs or PMCLs. Trace amounts of two phenols were detected in a water sample from SL 9, and 508 mg/kg of barium was detected in a sediment sample from SL 3, the reserve pit sample.

Walakpa No. 2

Location and Drilling Characteristics

Latitude: 71°03'00.44" *Longitude*: 156°57'09.70"

Location: T. 20 N., R. 19 W. Sec. 31 NE 1/4, Umiat Meridian

Depth: 4,360 ft *Drilled:* 1/3/81 - 2/15/81

Description

Walakpa Test Well No. 2 (plate 26A) is about 17 mi south of Barrow in relatively flat, polygon-shaped tundra. The wellsite was seeded and fertilized in 1981, and fertilized again in 1982. Water-quality samples for metals analysis were collected by Tetra Tech (1983) in February 1981. The site was visited in 1989 but not in 1990.

Drilling Pad: A thin pad was used. Material for the berms and pad were excavated from the reserve pit.

Reserve and Flare Pits: The pits were left open. Breaches occur on all sides except against the pad. Breaches on the western side allow water to flow into the pits. Breaches on the southern and eastern sides allow water to flow out. The reserve pit is 5.5 ft deep.

Summary of Reconnaissance Visit

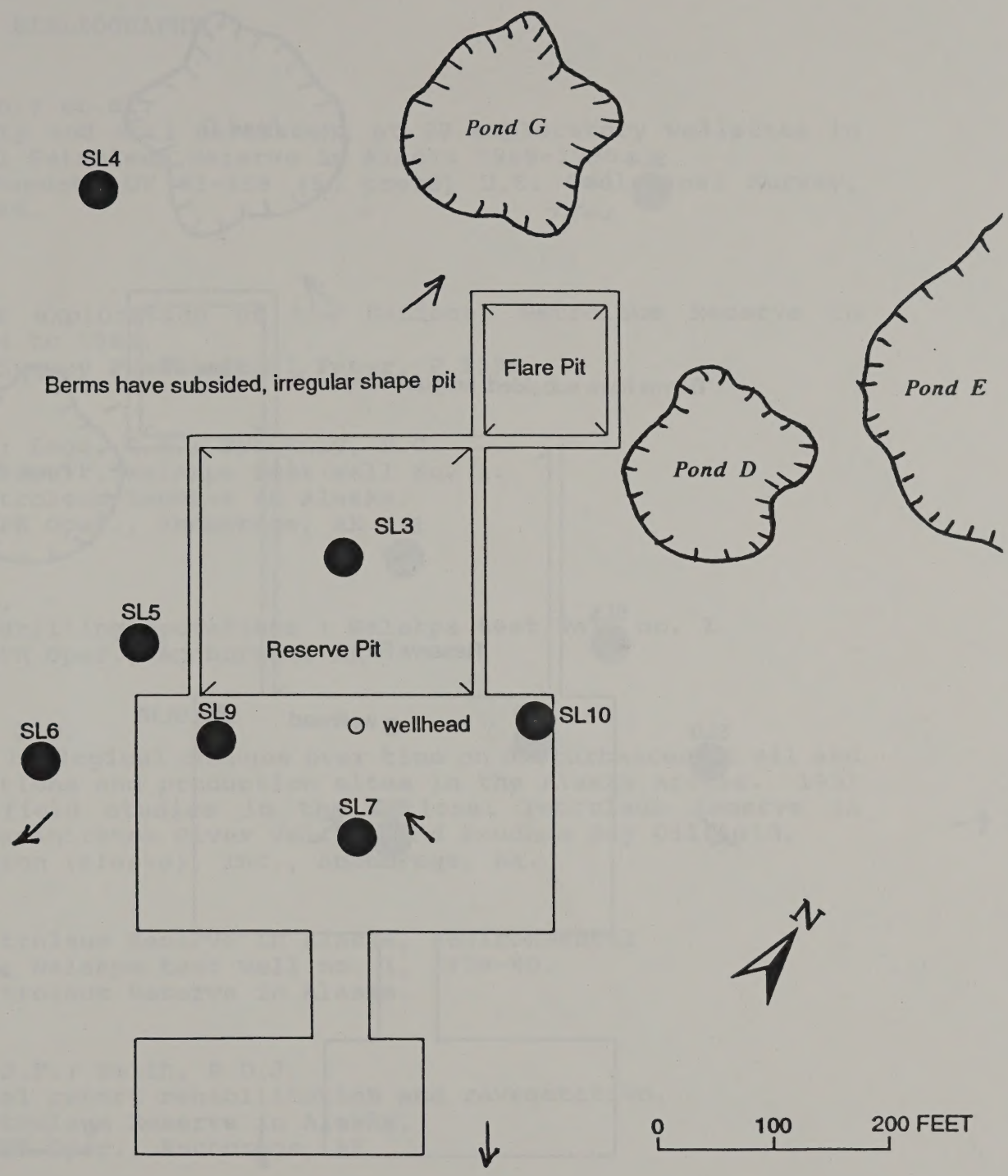
Walakpa No. 2 is located 500 ft from the western shore of a large lake. Drainage is toward the lake. The wellsite is fairly well revegetated.

The electromagnetic survey indicated background values of 8.6 to 8.9 mS/m (plate 26B). Values on the eastern, or downgradient, side of the pit were in the range of 10 to 15 mS/m, indicating flow of high-conductivity water from the reserve pit toward the lake. Specific conductances of water in ponds away from the pit were generally less than 200 µS/cm. Specific conductances of water in ponds on and downgradient from the pad and reserve pit were as much as 4,260 µS/cm.

The soil-gas survey detected readings of greater than 1,000 Vppm (plate 26C). A soil sample collected at the location of this high reading, SL 9, contained no VOCs and no TPH.

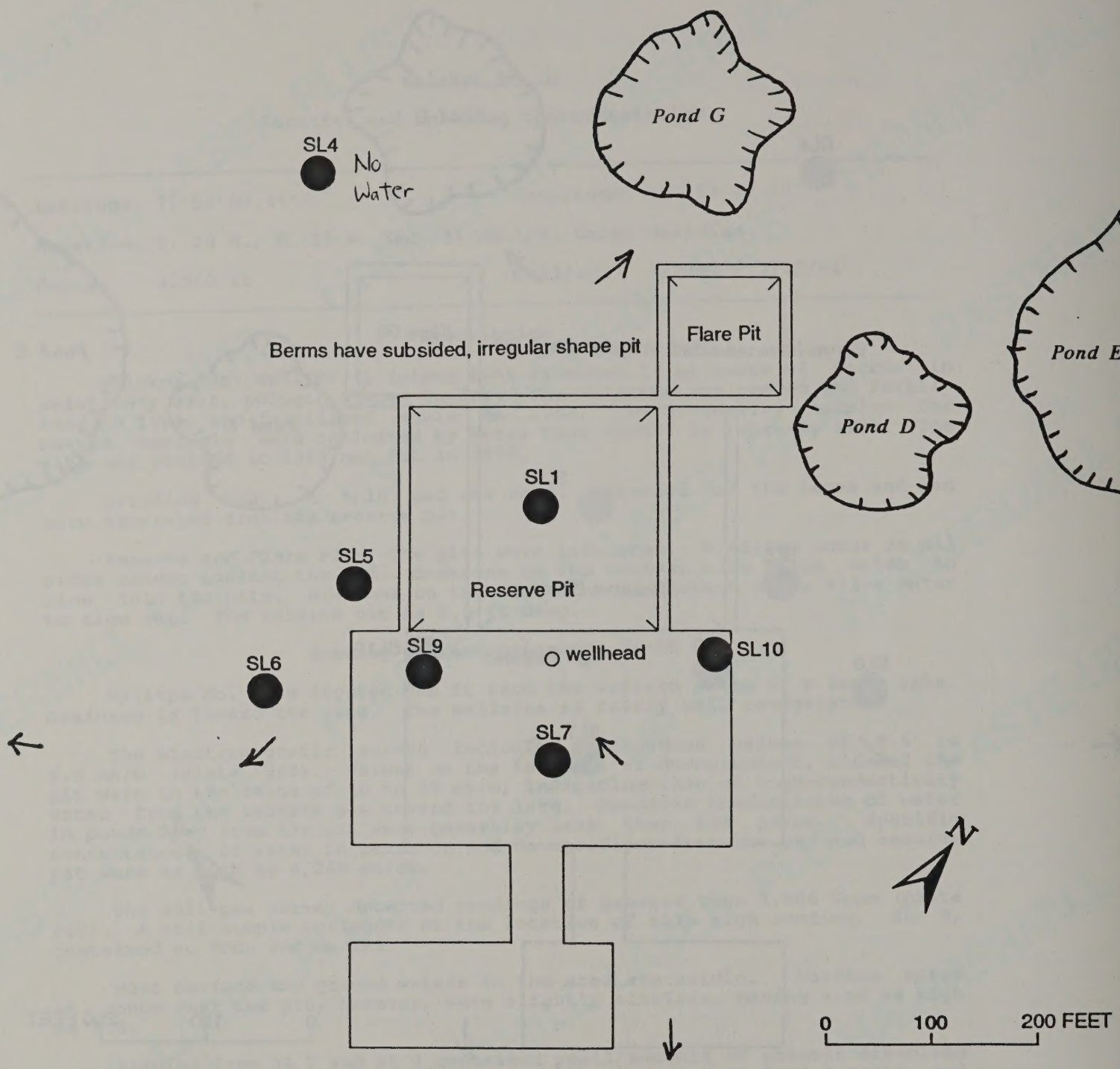
Most surface and ground waters in the area are acidic. Surface water in ponds near the pit, however, were slightly alkaline, having a pH as high as 8.5.

Samples from SL 7 and SL 9 contained small amounts of phenols dissolved in the water. Dissolved fluoride in water samples from SL 7 (4.2 mg/L) and SL 9 (4.1 mg/L) were above the MCL of 4.0 mg/L. Barium was detected in a water sample at SL 1 (confirmed by a duplicate sample) at a concentration of 1.1 mg/L, slightly above the MCL of 1.0 mg/L. A sediment sample in the reserve pit at SL 3 contained 1,100 mg/kg of TPH, 1,200 mg/kg of oil and grease, 2.3 mg/kg of napthalene, and 5.2 mg/kg of 2-methyl naphthalene. BTEX in the soil sample from this same location was 1.6 mg/kg.



Walakpa No. 1, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



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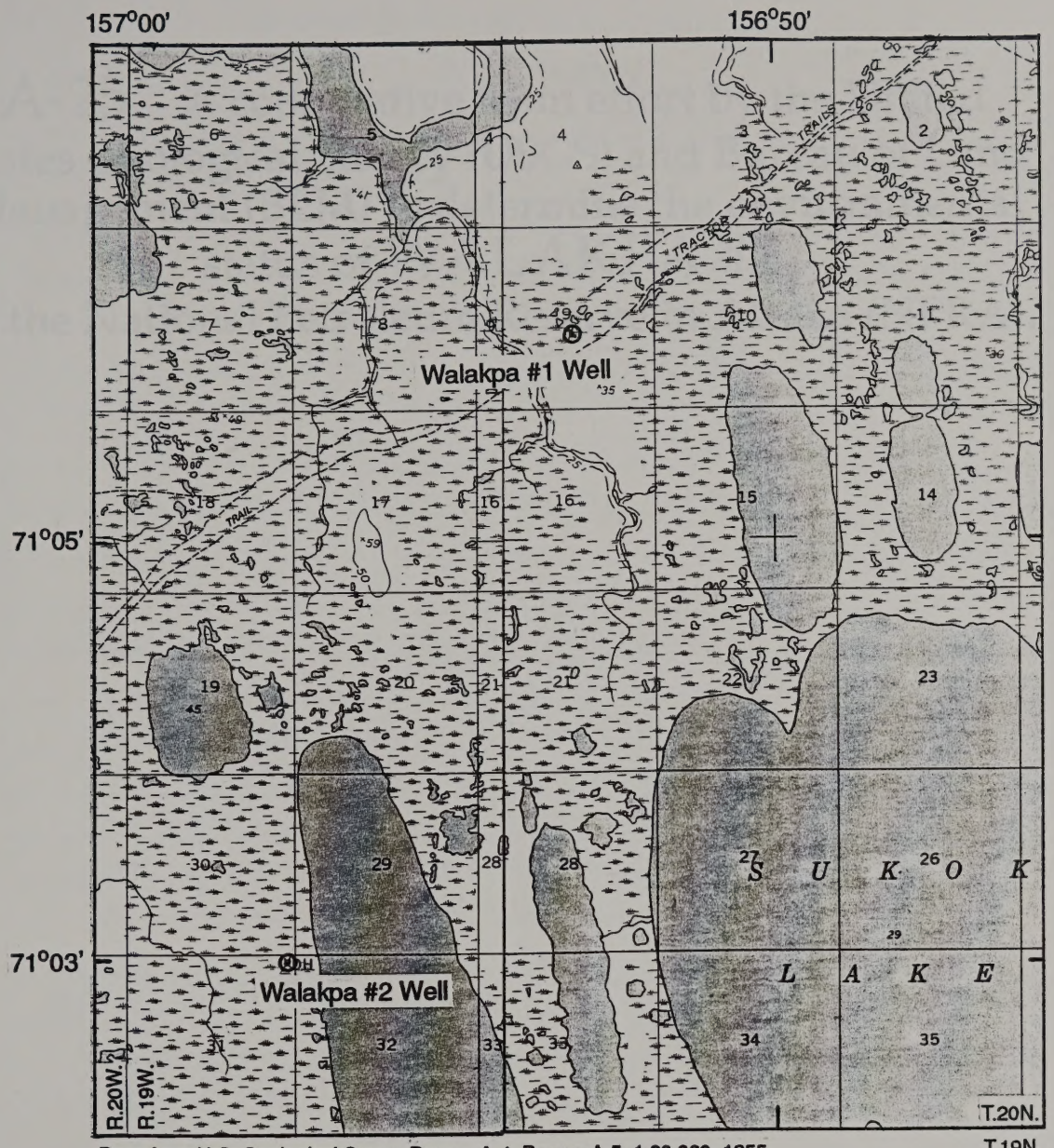
08-06-89 BLM 1:3600 WALARPA NO. 2 24-2-2



Base from U.S. Geological Suvey, Barrow A-4, Barrow A-5, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

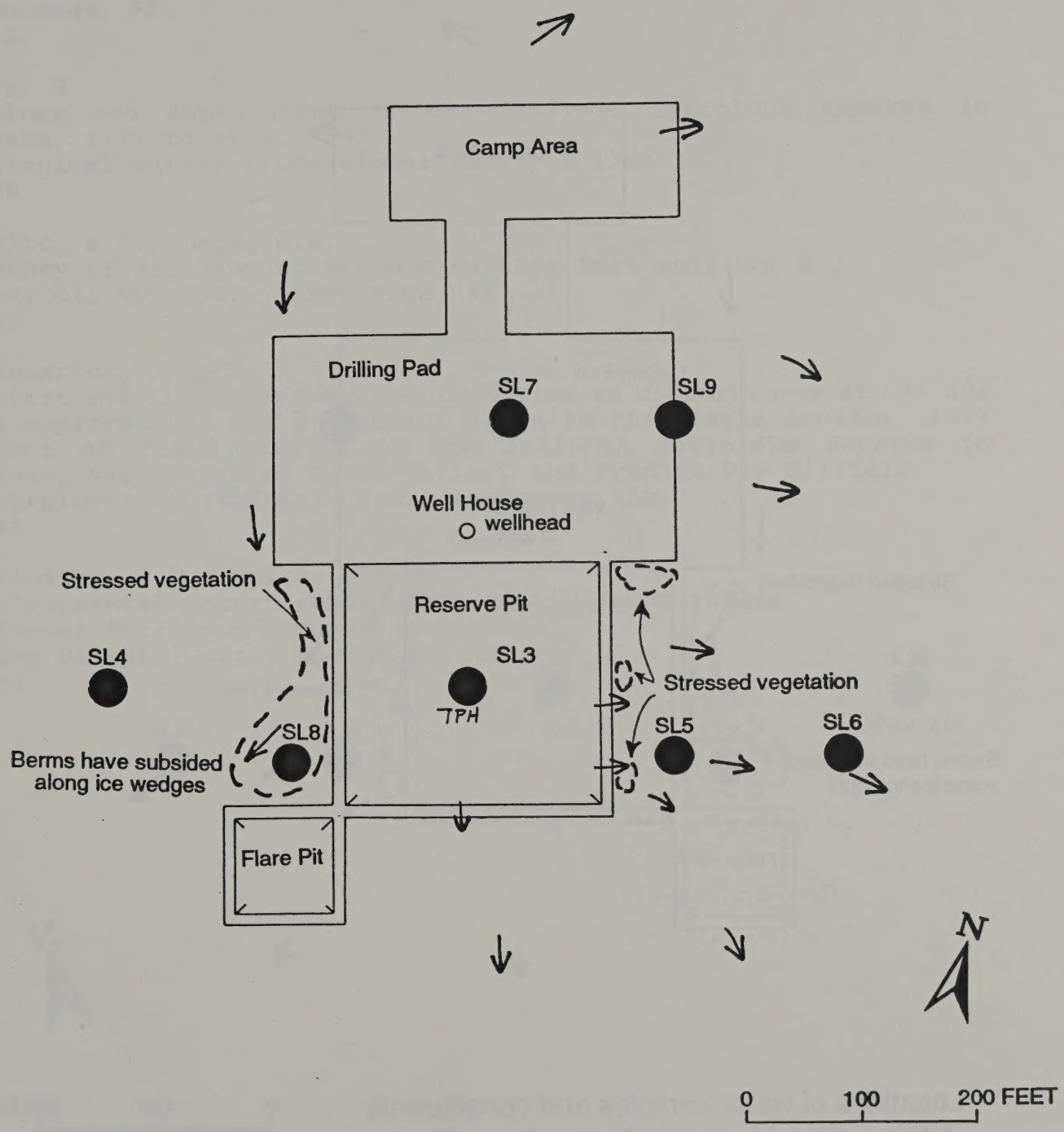
Location of Walakpa No. 1 well and Walakpa No.2 well.

A-25. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of WALAKPA #2 in the National Petroleum Reserve in Alaska (NPRA).

25. WELLSITE RISK DETERMINATION
WALAKPA #2

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1981(TETRA TECH),1989(USGS)
Prior Mitigation	Seeded and/or Fertilized in 1981, 1982
Leakage/Seepage	Natural surface drainage into and out of pit
Erosion	None
Subsidence	Occurring above ice wedges allowing inflow to and outflow from reserve and flare pits
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Well vegetated
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Covered by water up to 5 1/2 feet in reserve pit
Other Solids	None observed
Hydrocarbon Residue	TPH, BTEX elevated above background in reserve pit
Contaminant Level	Barium elevated in 1989 survey-Barium is below 1992 MCLs and Fluoride elevated above background in water. TPH elevated above background
Contaminant Migration	Localized in reserve pit or on pad
Contaminant Persistence	Associated with sediments. Site more than 11 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible*

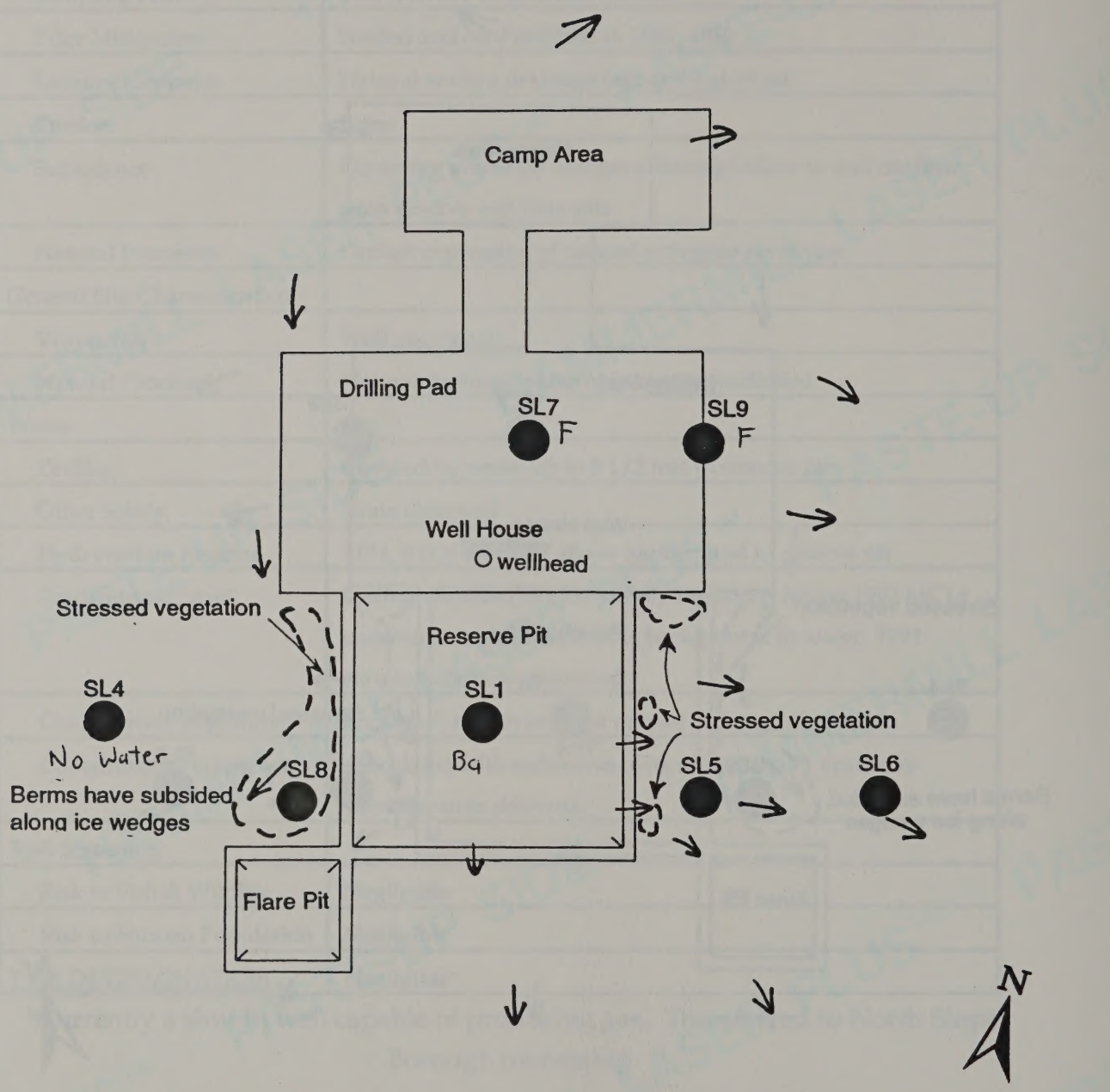
*Currently a shut in well capable of producing gas. Transferred to North Slope Borough ownership



Walakpa No. 2, 1989

Locations of soil samples and constituents having concentrations above criteria levels.

Pond L



Locations of water samples and constituents having concentrations above criteria levels

0 100 200 FEET

Walakpa No. 2, 1989

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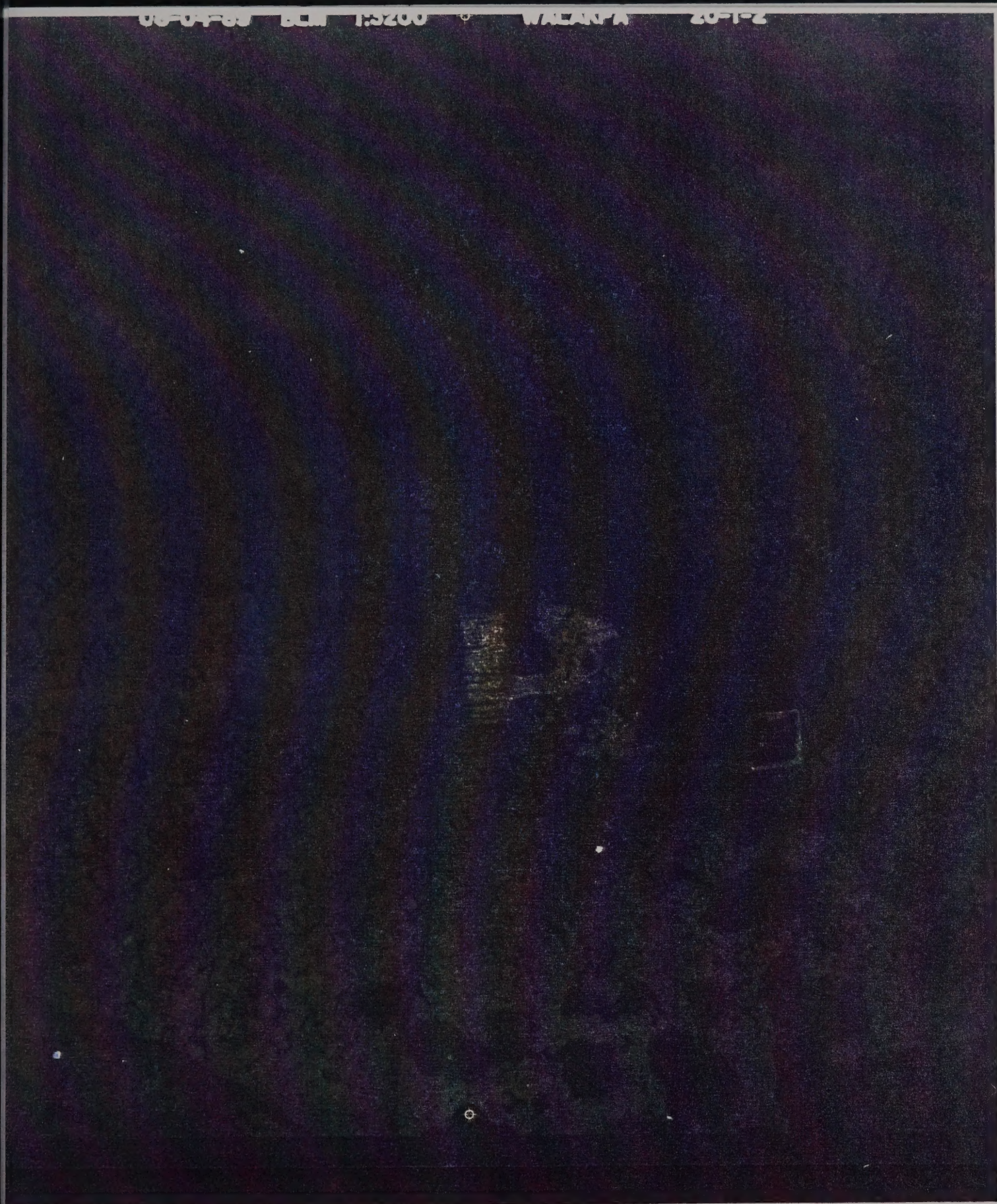
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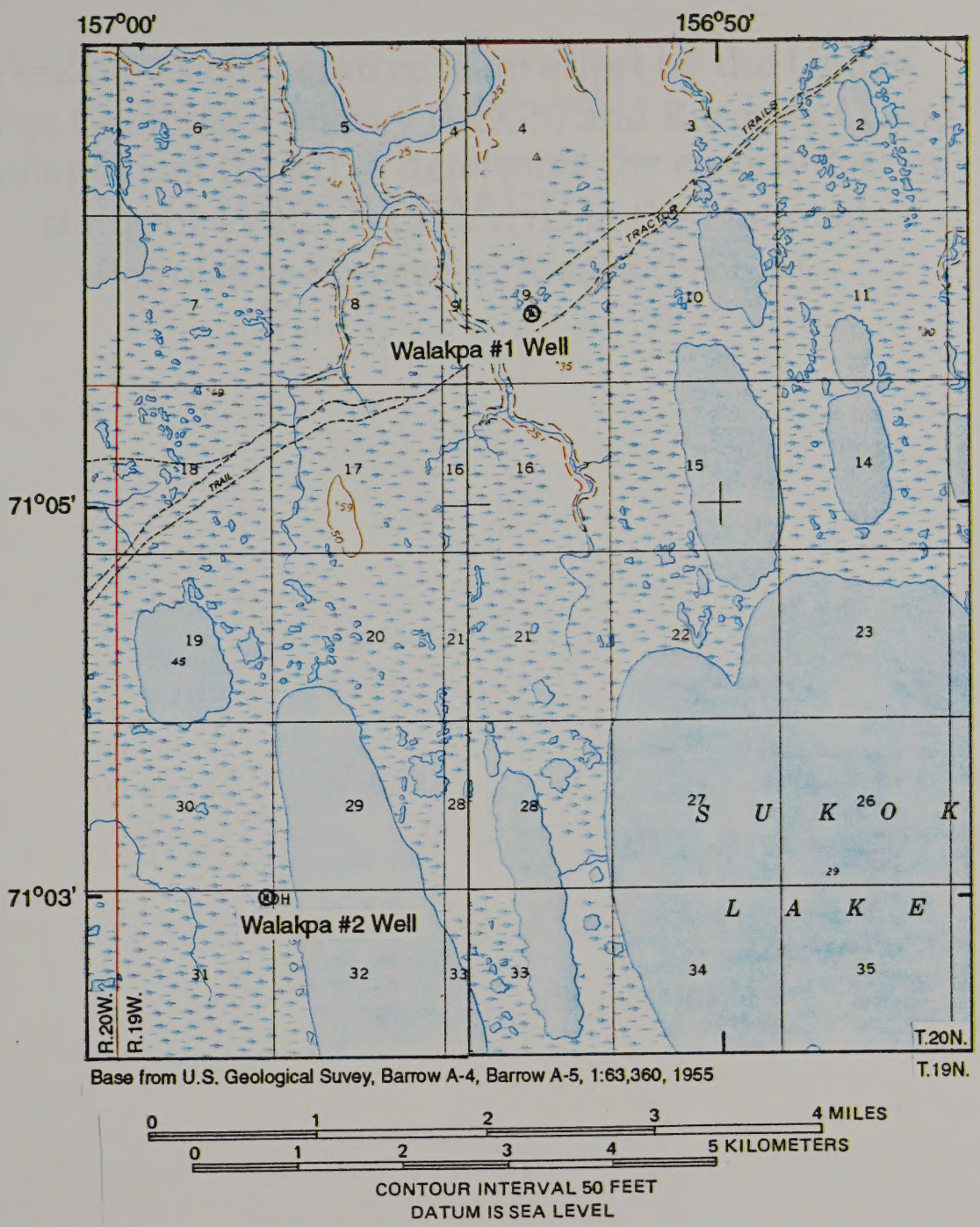
WALAKPA
20-1-2



Location of Walakpa No. 1 well and Walakpa No.2 well.

A-26. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of WEST DEASE in the National Petroleum Reserve in Alaska (NPRA).

26. WELLSITE RISK DETERMINATION
WEST DEASE

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1984(NUERA), 1989(USGS)
Prior Mitigation	Seeded and/or Fertilized 1980,1981,1982
Leakage/Seepage	Natural surface drainage patterns into and out of pit
Erosion	None
Subsidence	Pit subsided through melting underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Poor- brine in fill material
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Currently covered by up to 7 feet of water in reserve pit
Other Solids	None observed
Hydrocarbon Residue	TPH, BTEX elevated above background in reserve pit
Contaminant Level	TPH, BTEX elevated above background in reserve pit
Contaminant Migration	Contaminants localized in reserve pit.
Contaminant Persistence	Associated with sediments. Site more than 12 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

West Dease

Location and Drilling Characteristics

Latitude: 71°09′32.65" *Longitude*: 155°37′45.19"

Location: T. 21 N., R. 14 W., Sec. 21 NE 1/4, Umiat Meridian

Depth: 4,170 ft *Drilled*: 2/19/80 - 3/26/80

Description

West Dease Test Well No. 1 (plate 27A) is about 28 mi east-southeast of Barrow in a wet sedge meadow dominated by low-centered polygons. The ground at the wellsite is about 5 ft above sea level. The wellsite was seeded and fertilized in 1980 and 1982 and fertilized only in 1981. The drilling mud used had a high calcium chloride content (greater than 100,000 mg/L Cl and greater than 60,000 mg/L Ca). Also, the pad material might have high salinity. Water-quality samples were collected by the Nuera Reclamation Company in 1984. The wellsite was visited in both 1989 and 1990.

PREVIOUS WATER-QUALITY DATA FOR RESERVE PIT

Date	Temperature	pH	Specific conductance	Reference
7/6/84	3.0-5.0 °C	7.9-8.0	1,710-1,780 µS/cm	Nuera Reclamation Company (1986, p. 79-80)

Drilling Pad: Materials for the berms and thin pad were excavated from the reserve pit. During spring thaw, the pad subsided to an irregular shape.

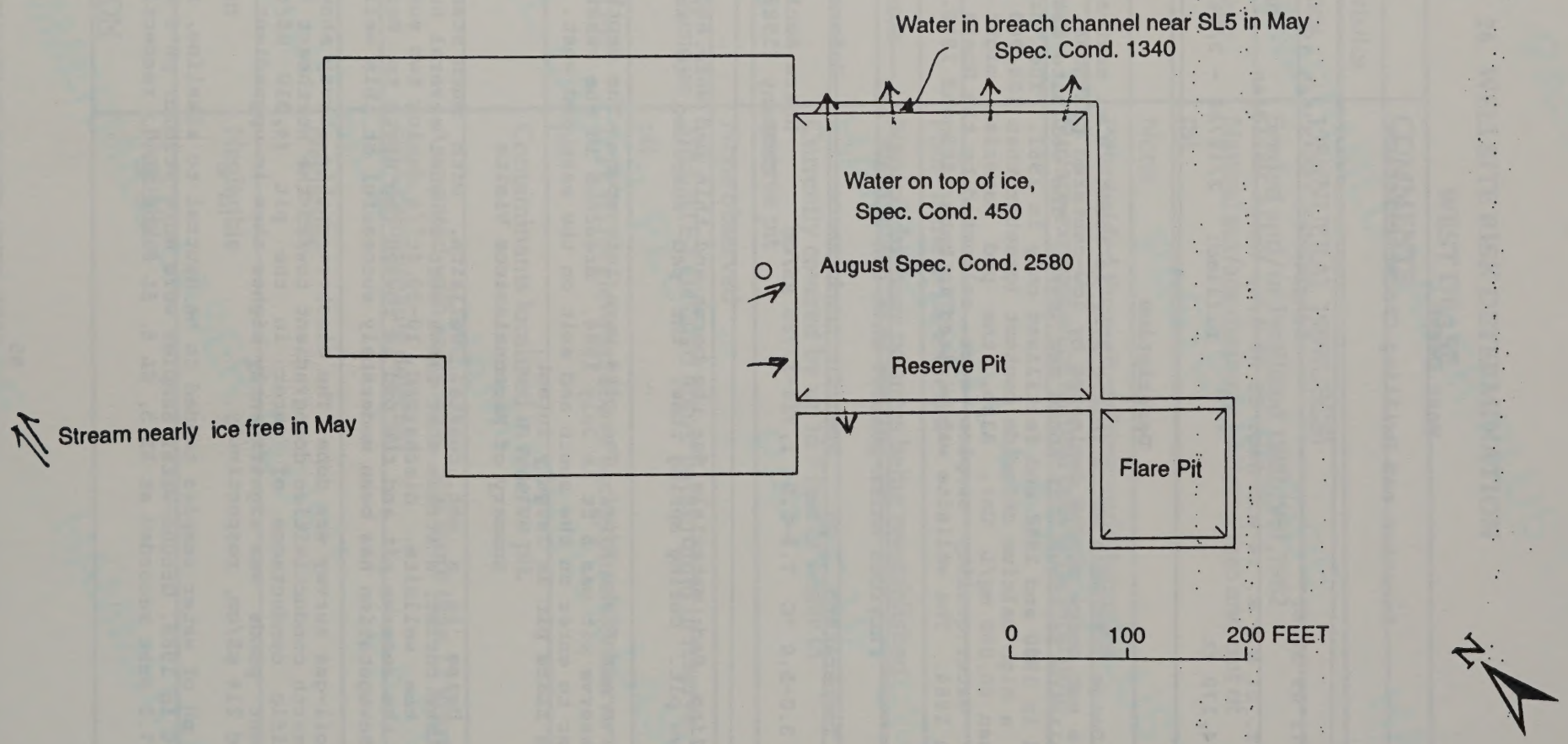
Reserve and Flare Pits: The pits were left open. The depth of water in the reserve pit was 5 ft in July 1984. Breaches in the reserve pit berm allow water to enter on the south and exit on the east and west. The berm around the flare pit is largely intact.

Summary of Reconnaissance Visits

West Dease is a wet coastal wellsite, with much standing water. Reindeer Lake outlet, a stream that flows west to east several hundred feet north of the wellsite, discharged 10-50 ft^3/s during two summer visits. Flow near the reserve pit and the pad is toward the north to Reindeer Lake outlet. Revegetation has been moderately successful at this wellsite.

No soil-gas survey was done. The electromagnetic survey showed somewhat elevated earth conductivities downgradient toward the northeast (plate 27B). The specific conductance of water in the pit (4,310 µS/cm) and in downgradient ponds was significantly higher than in upgradient Ponds D and H, 247 and 214 µS/cm, respectively.

The pH of water samples tended to be neutral to alkaline, ranging from 6.6 to 9.6 in 1989. Ground-water samples were more acidic; pH's of 5.4, 5.6, 5.8, and 7.2 were recorded at SL 5, SL 6, SL 8 and SL 7, respectively.



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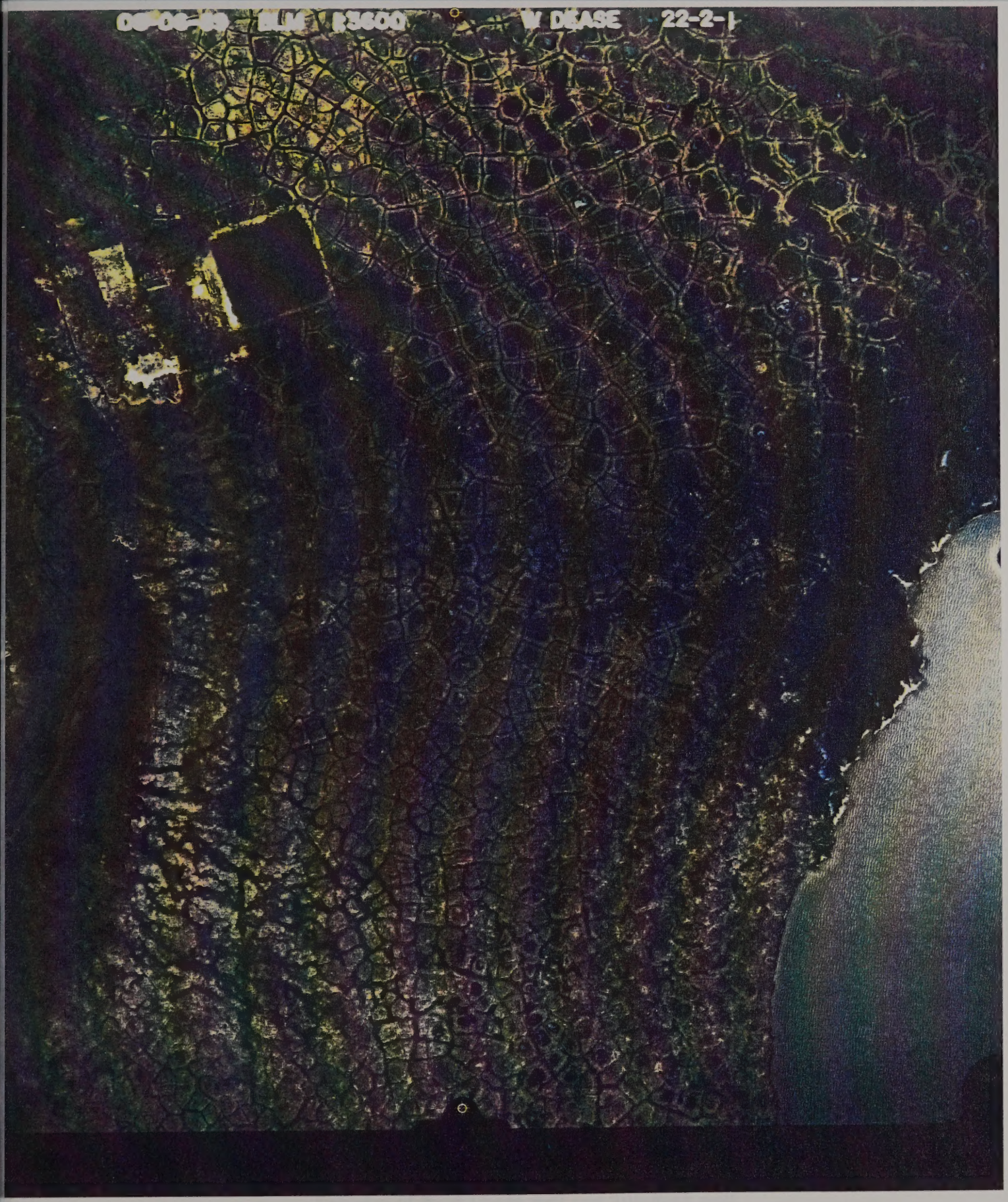
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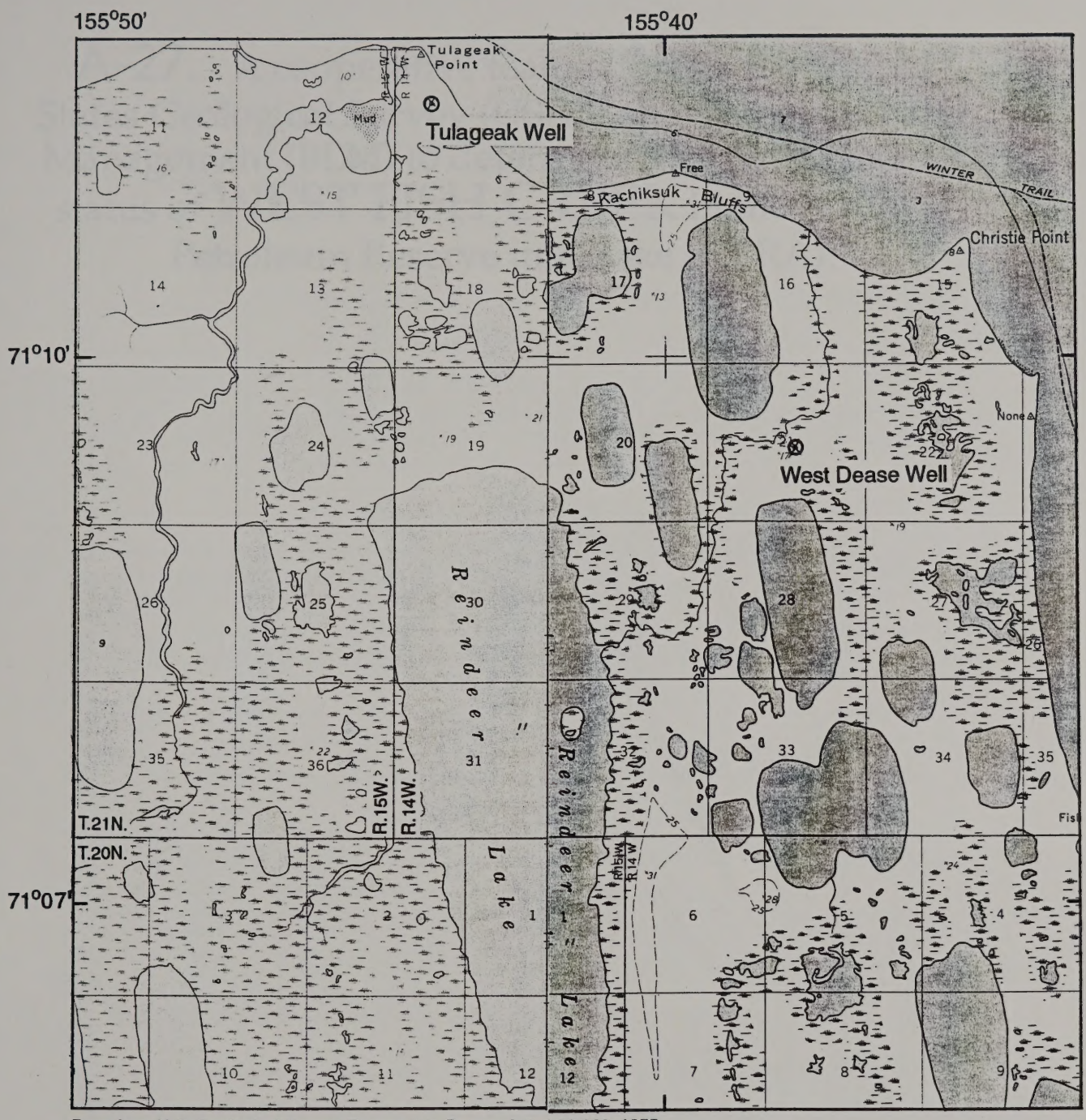


Base from U.S. Geological Survey, Barrow A-2, Barrow A-3, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of West Dease well and Tulageak well.

A-27. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of WEST FISH CREEK in the National Petroleum Reserve in Alaska (NPRA).

27. WELLSITE RISK DETERMINATION
WEST FISH CREEK

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Backfilled and recontoured. Seeded and/or Fertilized 1978
Leakage/Seepage	Pond formed in former reserve pit area
Erosion	None
Subsidence	Pit subsidence through melting of underlying ice
Natural Processes	Surface expression of natural polygons returning
General Site Characteristics	
Vegetation	Heavily revegetated
Natural Processes	Natural drainage patterns being reestablished
Waste	
Drilling	Covered by pad material and up to 3 1/2 feet of water
Other Solids	None observed
Hydrocarbon Residue	TPH elevated above background on one site near pad
Contaminant Level	Barium above MCL, TPH elevated above background
Contaminant Migration	Localized
Contaminant Persistence	Associated with sediments. Site more than 15 years old-Contaminants detected.
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

West Fish Creek

Location and Drilling Characteristics

Latitude: 70°19′35.99" *Longitude*: 152°03′38.03"

Location: T. 11 N., R. 1 W., Sec. 11 NW 1/4, Umiat Meridian

Depth: 11,427 ft *Drilled*: 2/14/77 - 4/27/77

Description

West Fish Creek Test Well No. 1 (plate 28A) is about 126 mi southeast of Barrow. The ground is about 87 ft above sea level and is subject to spring flooding. During June 1982, much of the pad and surrounding area were inundated and water in the reserve pit was mixing with flood water. No historic water-quality data are available. The site was visited in 1989, but not in 1990.

Drilling Pad: Materials for construction of the thick pad were well-drained sand taken from a high sand bank of an unnamed lake about 2.2 mi to the west-northwest of the wellsite. Following drilling, the pad was recontoured, and the pits were backfilled.

Reserve and Flare Pits: The pits were backfilled with thawed sand. After the sand settled, the reserve pit is about 40 percent backfilled. Water might be escaping during snowmelt and periods of heavy precipitation. No breaches were visible.

Summary of Reconnaissance Visit

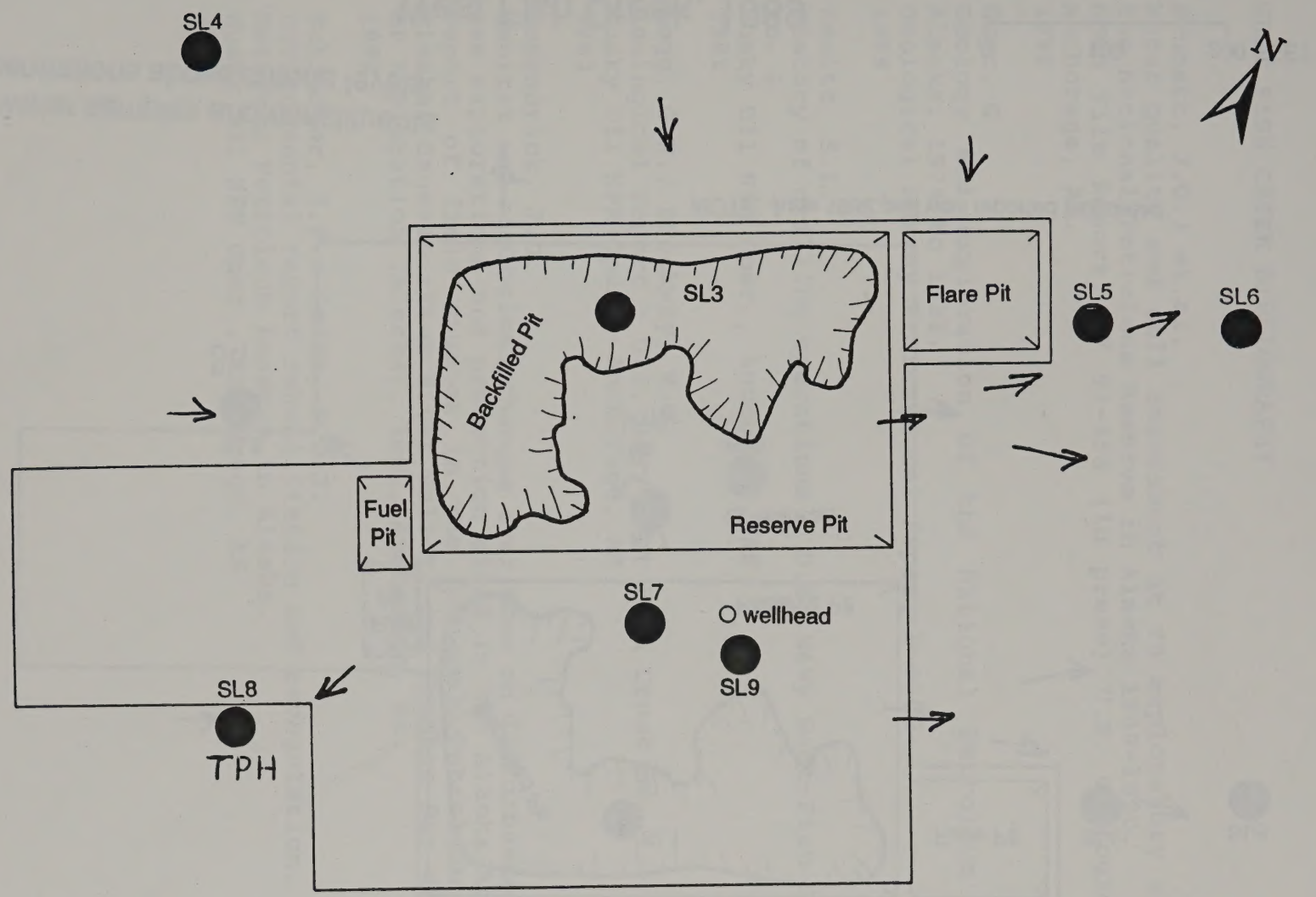
Less than 0.5 ft of difference in elevation exists among the water surfaces across this wellsite. Flow is generally to the east, probably toward an unnamed lake having an outlet to Harrison Bay. Water flows into the reserve pit on the northwestern side and out of the pit on the other sides. Vegetation has started to establish itself, and the wellsite is approximately 50 percent revegetated.

The electromagnetic survey indicated earth conductivity values of less than 5 mS/m throughout most of the perimeter of the wellsite (plate 28B). A few readings greater than 5 mS/m were registered between mid pad and mid pit. The soil-gas concentrations were elevated at SL 9, where a sample was collected (plate 28C). The soil sample from SL 9, however, had no VOC or TPH concentrations.

The highest specific conductance value in water was at SL 8, which was receiving drainage from the pad. The specific conductance of water in the reserve pit was 714 µS/cm. Specific conductances seemed to decrease in both ponds and ground water downgradient from the wellsite. Specific conductances of water in Ponds B and A decreased from 957 to 647 µS/cm, and specific conductances of ground-water samples also indicated a decreasing progression of specific conductance from 573 to 338 µS/cm. The lowest specific conductance, at 223 µS/cm, was in water from the flare pit, however.

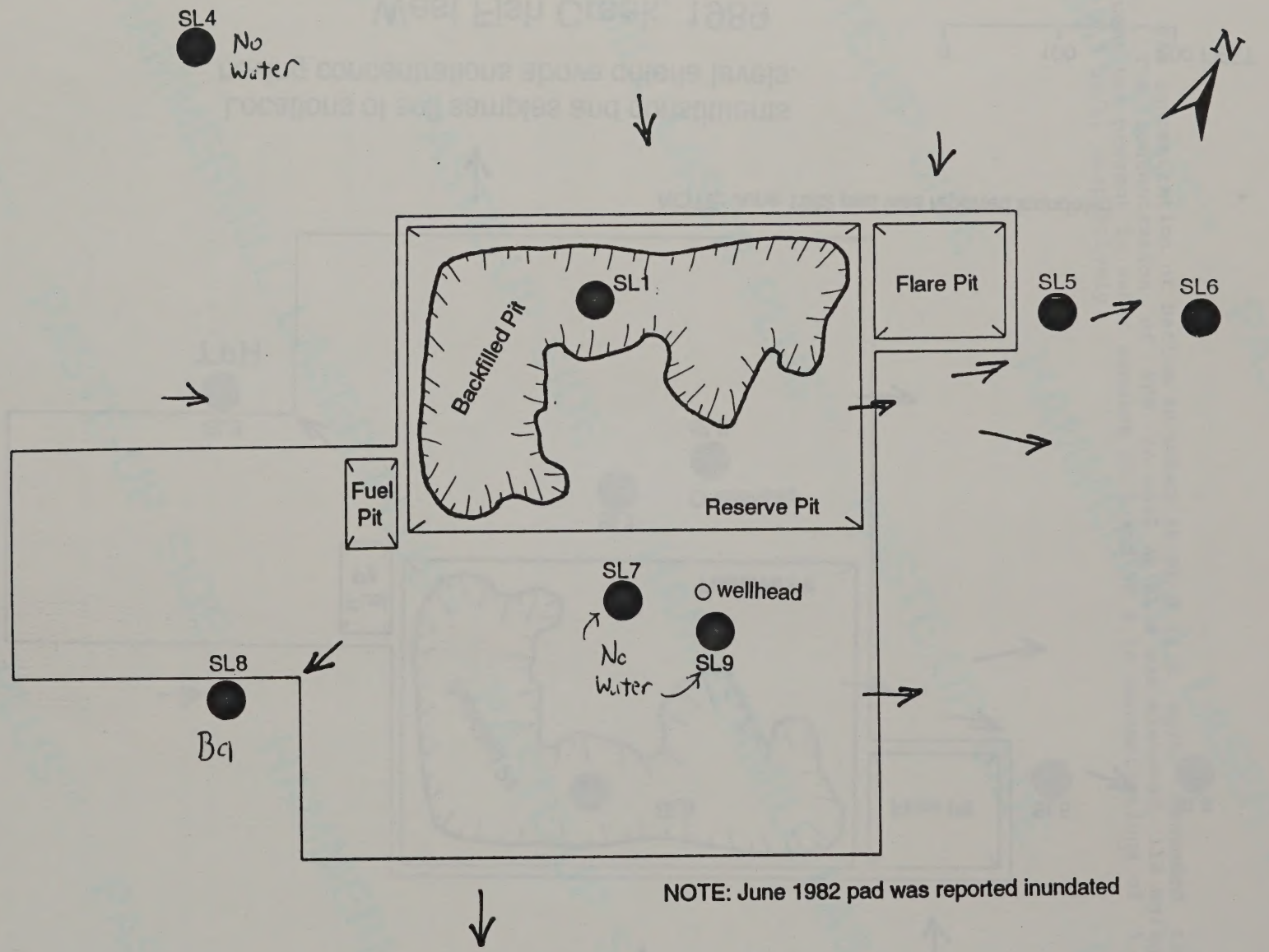
The pH of water samples tended to be neutral to alkaline and ranged from 7.3 to 9.0, except for two upgradient ponds that had pH's of 6.5 and 6.8. Ground-water samples were more acidic and had pH's of 5.7, 5.9, and 6.3.

The concentration of barium in water at SL 8 (1.2 mg/L) exceeded the MCL. The concentration of TPH in soil at SL 8 was elevated, 110 mg/kg. Toluene was present in water samples SL 5 and SL 6 in concentrations of 1.3 and 2.8 µg/L, respectively.



Locations of soil samples and constituents having concentrations above criteria levels.

West Fish Creek, 1989



Locations of water samples and constituents having concentrations above criteria levels

0 100 200 FEET

West Fish Creek, 1989

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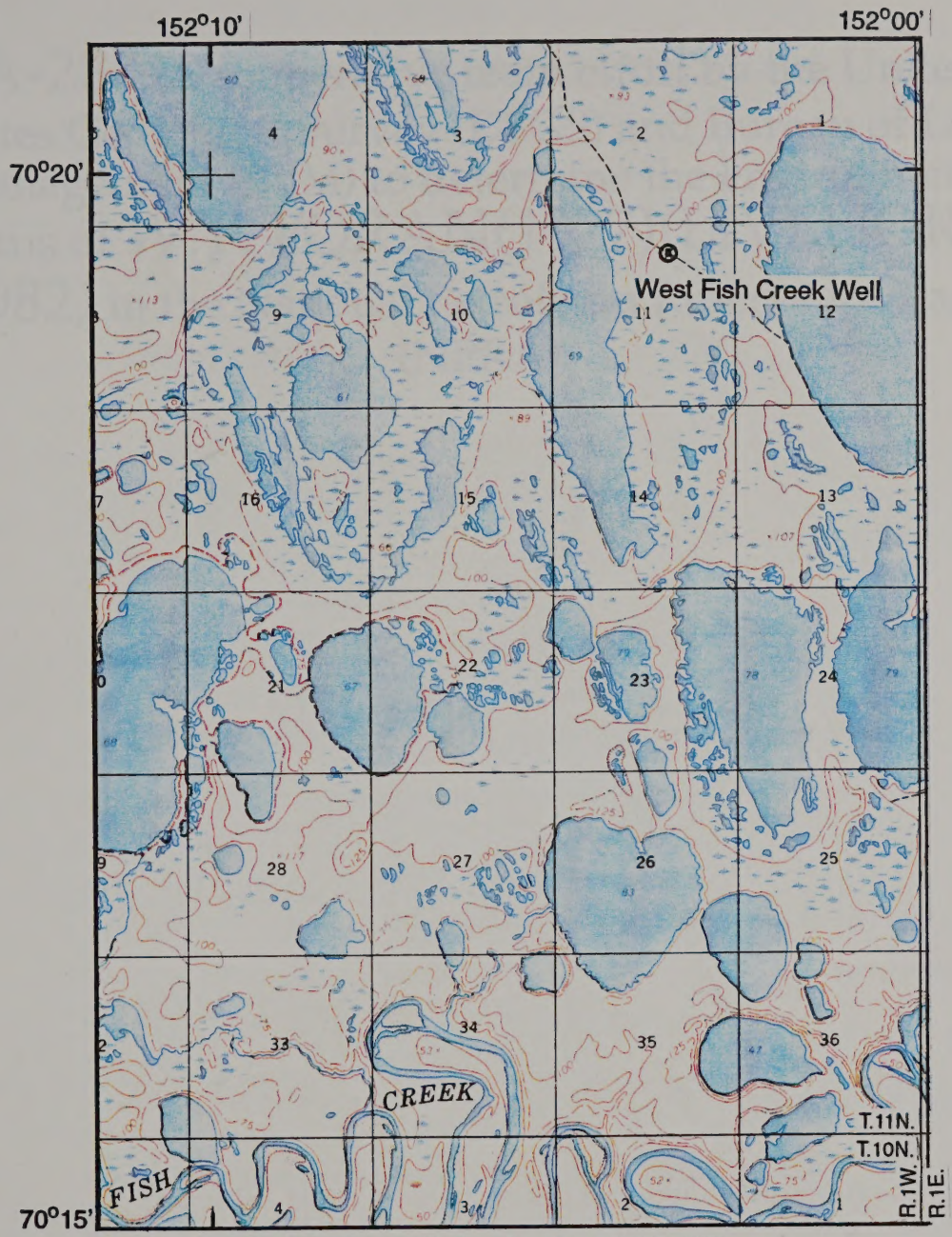


Base from U.S. Geological Survey, Harrison Bay B-4, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of West Fish Creek well.

A-28. A cooperative team effort by the United States Geological Survey (USGS) and Bureau of Land Management (BLM) to determine the environmental status of W.T. FORAN(1977)(LIVEHORSE 1982) in the National Petroleum Reserve in Alaska (NPRA).

28. WELLSITE RISK DETERMINATION
W.T.FORAN(1977)(LIVEHORSE 1982)*

OBSERVATION	COMMENTS
Wellsite Characteristics	
Sampling History	1989(USGS)
Prior Mitigation	Backfilled and recontoured in 1978. Seeded and Fertilized in 1978,1979,1980 and 1981.
Leakage/Seepage	Natural surface water drainage into and out of pit
Erosion	None
Subsidence	Minimal subsidence
Natural Processes	Muted surface expression of natural polygons returning
General Site Characteristics	
Vegetation	None on pad. Stressed vegetation off pad
Natural Processes	Runoff dissolving salts which are deposited around pad
Waste	
Drilling	Some waste exposed on pad and covered reserve pit*
Other Solids	None observed
Hydrocarbon Residue	Occurrence of 4- Methyl Phenol at two sampling sites
Contaminant Level	Barium is elevated above MCL at 2 sites
Contaminant Migration	Salts are migrating from pad to surrounding area
Contaminant Persistence	Associated with sediments. Site more than 15 years old- Contaminants detected. Salts are diluting off pad
Risk Screening	
Risk to Fish & Wildlife	Negligible
Risk to Human Population	Negligible
RISK DETERMINATION	Negligible

*Second operator in 1982 dug out original waste pit for reuse. Excavated pit materials reused on second pad. These materials subsequently refilled original reserve pit. Not seeded in 1982

W.T. Foran

Location and Drilling Characteristics

Latitude: 70°49'56.01" *Longitude*: 152°18'11.23"

Location: T. 17 N., R. 2 W., Sec. 13 NW 1/4, Umiat Meridian

Depth: 8,864 ft *Drilled*: 3/7/77 - 4/24/77

Description

W.T. Foran Test Well No. 1 (plate 29A) is about 105 mi east-southeast of Barrow. The site was seeded and fertilized in 1979, 1980, and 1982, and fertilized only in 1981. No water-quality data were available prior to 1989. The wellsite was visited in 1989 but not in 1990.

Drilling Pad: Materials for the berms and thick pad were obtained from Cameron Point, 9 mi west of the wellsite.

Reserve and Flare Pits: The pits were backfilled with thawed sand. The backfilled materials were later excavated by a private company in 1982, spread over the pad, and finally, pushed back into the reserve pit.

Summary of Reconnaissance Visit

After the wellsite had been closed, the property was transferred to a private corporation. Under a lease from the owners, Chevron, Inc. excavated the fill from the reserve pit and spread the materials back over the work pad in order to construct a second well, the Livehorse well, in 1982. This second reserve pit was somewhat smaller than the original pit, and both outlines are visible on the aerial photographs. Following the completion of the Livehorse well, the pad was scraped into the reserve pit as backfill. As a result of this multiple reworking of materials, the wellsite is very muddy, and revegetation is virtually nonexistent.

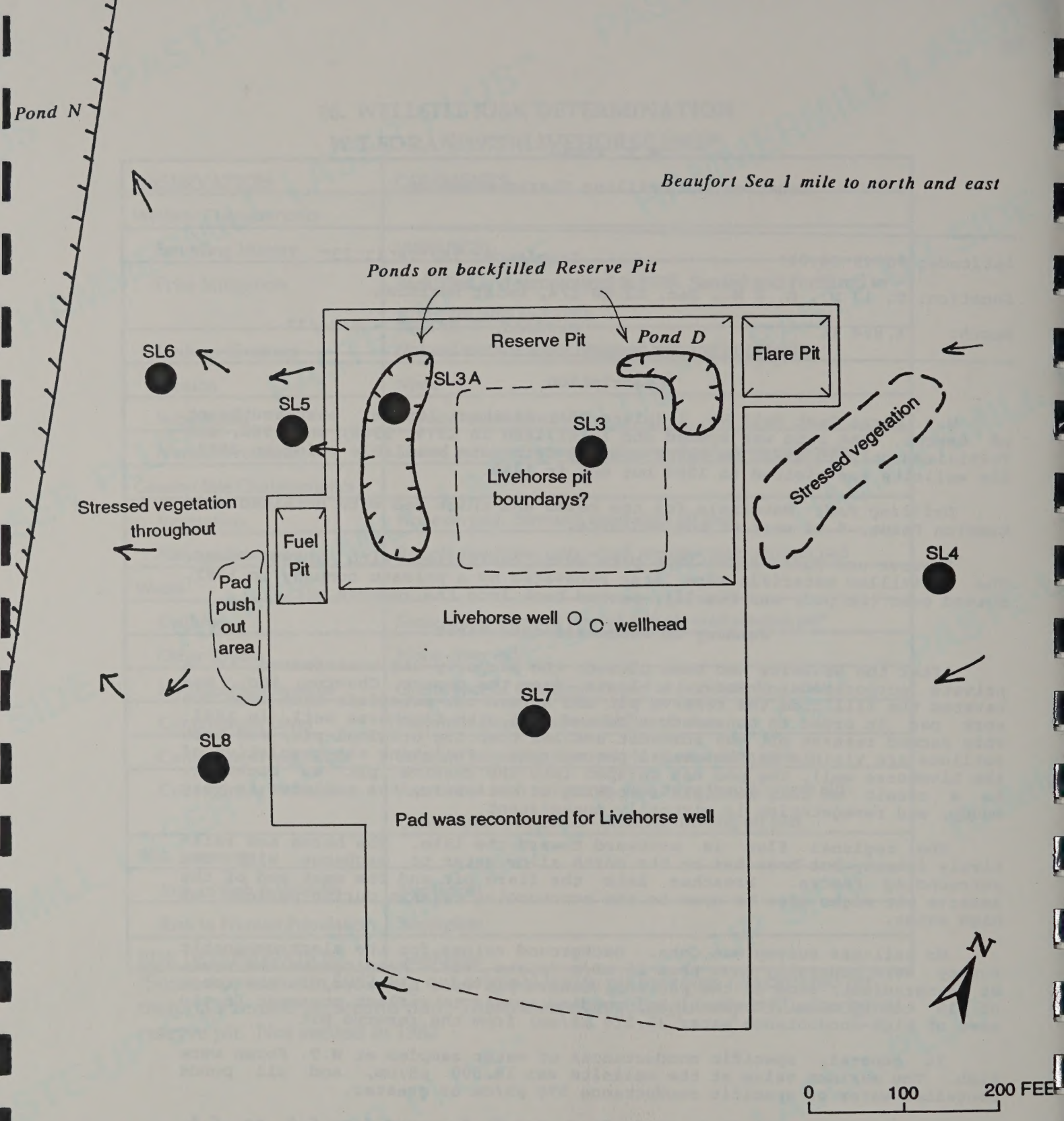
The regional flow is westward toward the lake. The berms are relatively intact, but breaches on the north allow water to exchange with the surrounding tundra. Breaches into the flare pit and the west end of the reserve pit might also be open to the surrounding terrain during periods of high water.

No soil-gas survey was done. Background values for the electromagnetic survey were generally less than 15 mS/m (plate 29B). Readings on the west, or downgradient, side of the pad and reserve pit were elevated, in the range of 15 to 60 mS/m. These higher reading appear to reflect movement to the east of high-conductance water (3,510 µS/cm) from the reserve pit.

In general, specific conductances of water samples at W.T. Foran were high. The maximum value at the wellsite was 18,500 µS/cm, and all ponds contained water of specific conductance 870 µS/cm or greater.

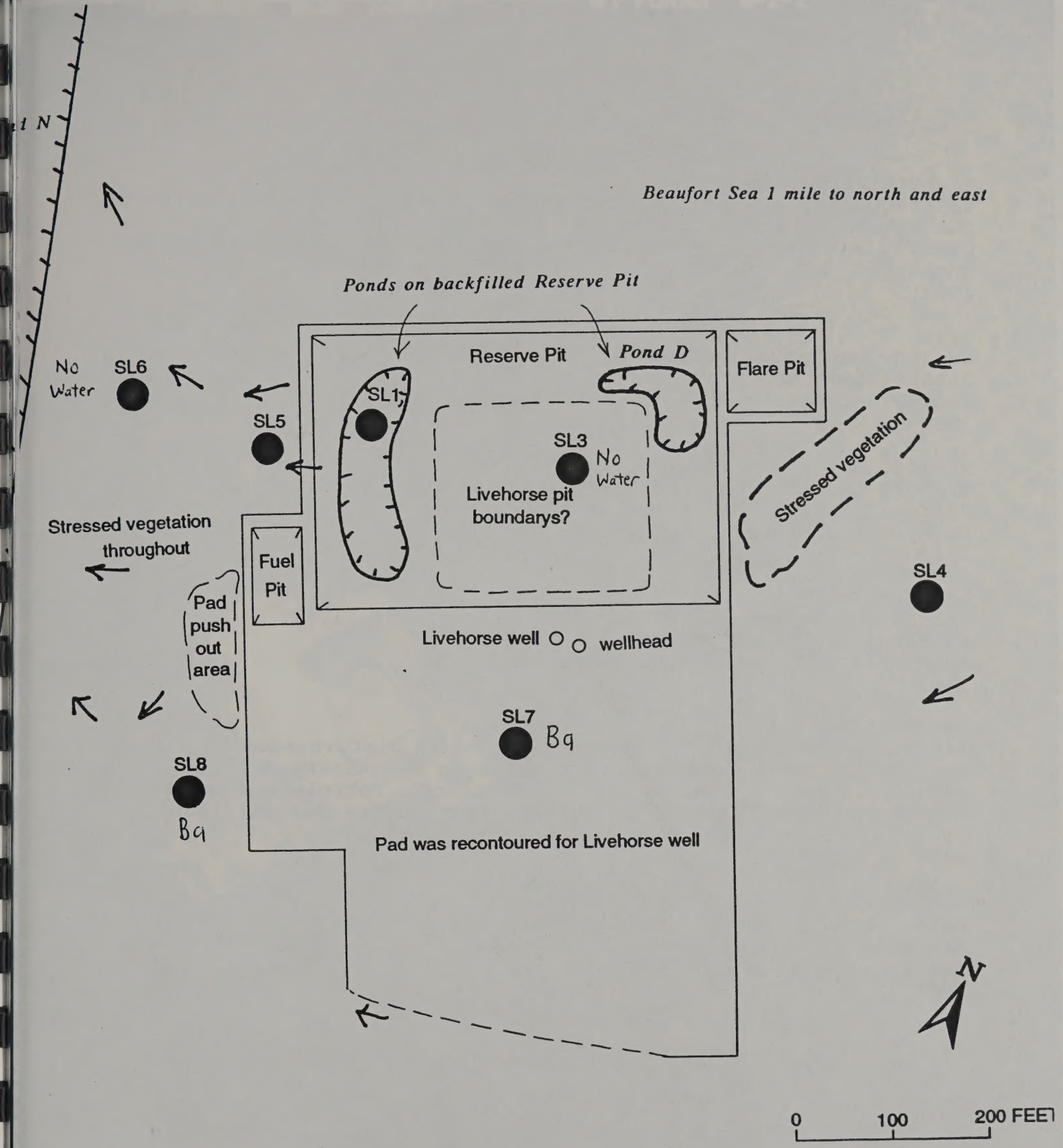
The pH of water at SL 4, SL 5, SL 6, and SL 7 ranged from 5.0 to 6.5. The pH of water in all ponds ranged from 7.6 to 9.6.

Water samples from SL 7 and SL 8 contained 2.2 and 2.0 mg/L of barium, respectively, both of which exceed the MCL of 1 mg/L. The water sample from SL 7 also contained 300 µg/L of benzoic acid and 270 µg/L of 4-methyl phenol.



W. T. Foran, 1989

Locations of soil samples and constituents having concentrations above criteria levels.



W. T. Foran, 1989

Locations of water samples and constituents having concentrations above criteria levels

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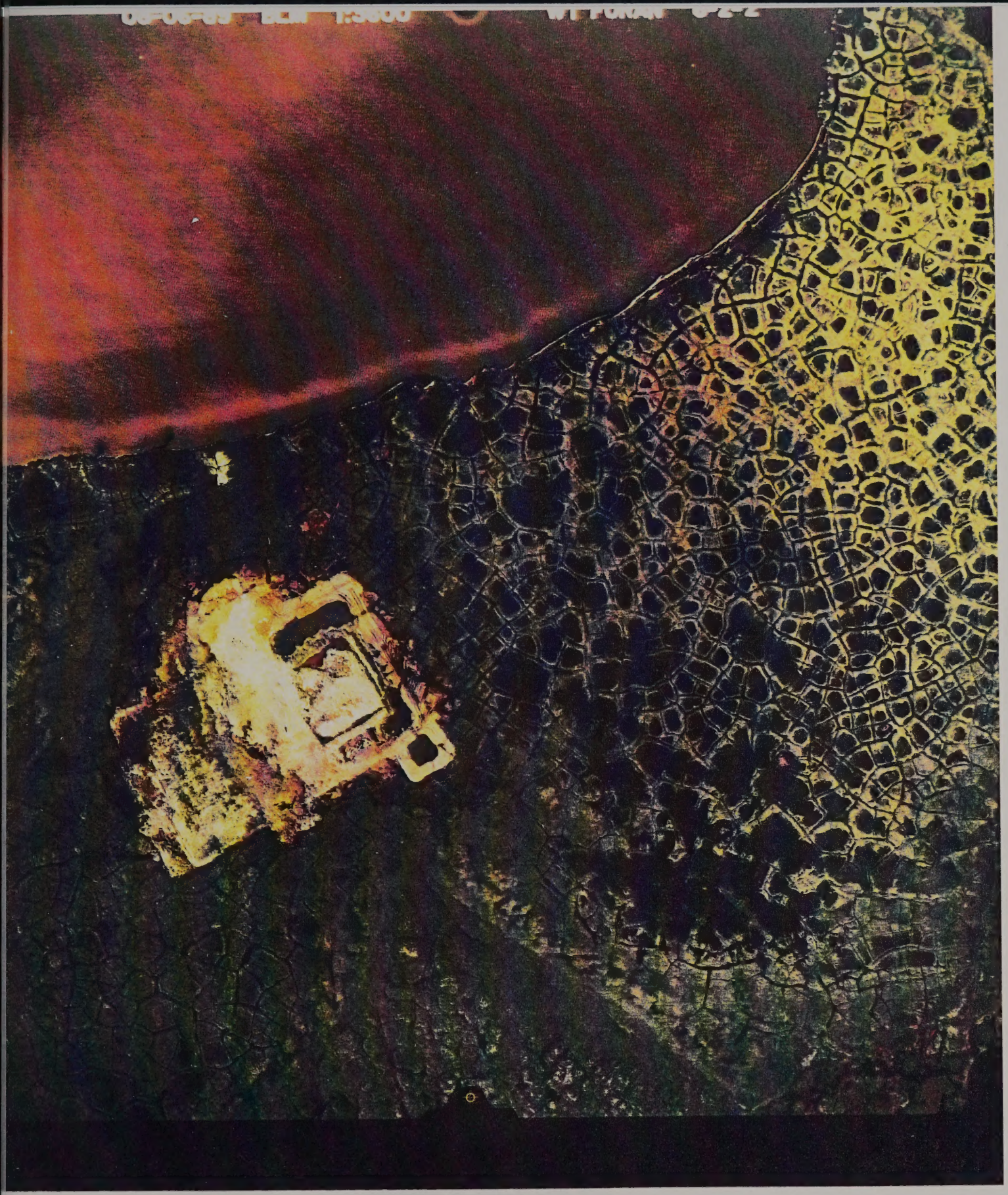

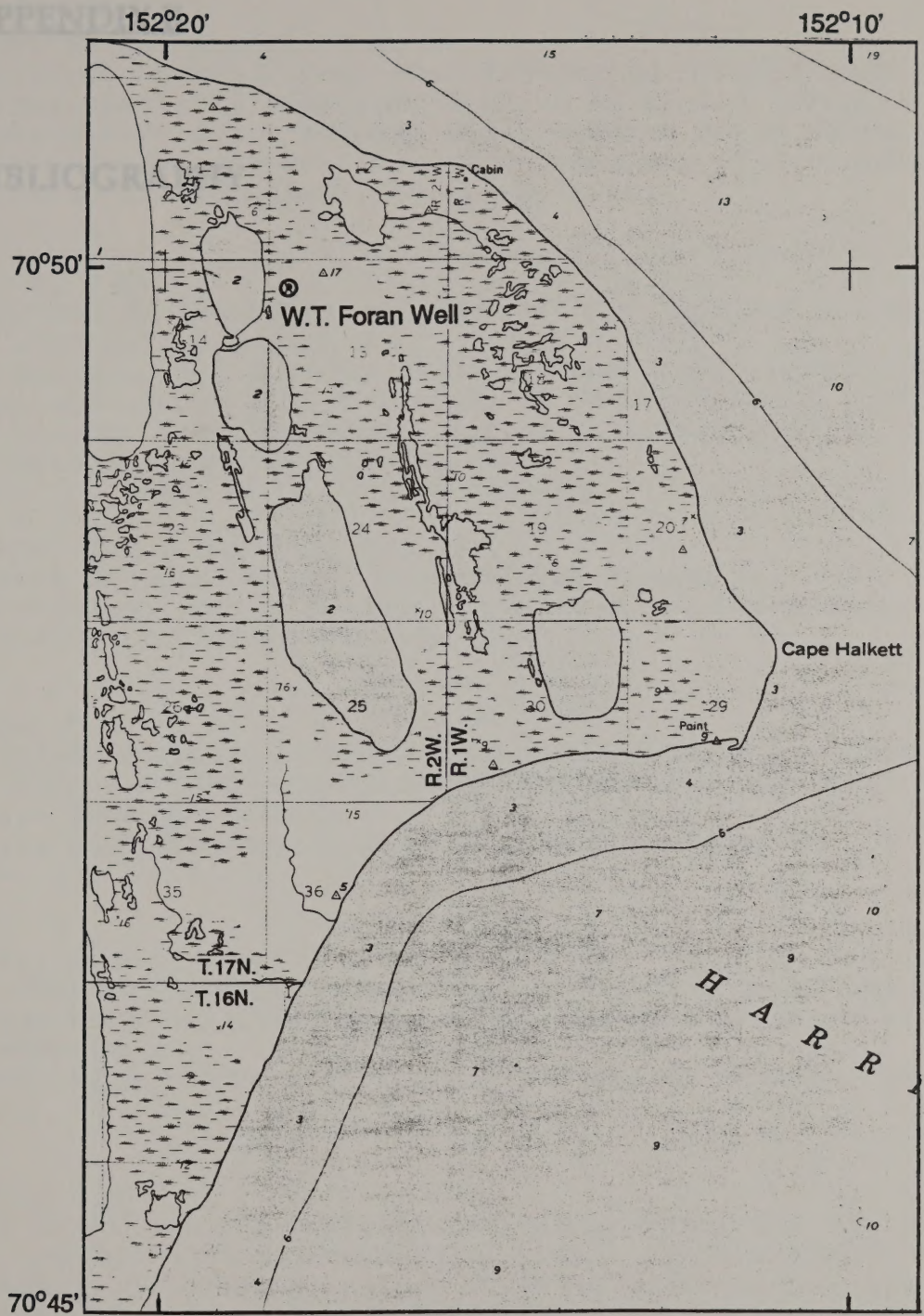

Base from U.S. Geological Survey, Harrison Bay D-4, 1:63,360, 1955

0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS SEA LEVEL

Location of W.T. Foran well

182°20'
182°10'
70°50'
70°45'
Cape Halkett
W.T. Foran Well
T.1N.
T.1S.
R.3W.
R.2W.
R.1W.
R.1E.
R.2E.
R.3E.
R.4E.
R.5E.
R.6E.
R.7E.
R.8E.
R.9E.
R.10E.
R.11E.
R.12E.
R.13E.
R.14E.
R.15E.
R.16E.
R.17E.
R.18E.
R.19E.
R.20E.
R.21E.
R.22E.
R.23E.
R.24E.
R.25E.
R.26E.
R.27E.
R.28E.
R.29E.
R.30E.
R.31E.
R.32E.
R.33E.
R.34E.
R.35E.
R.36E.
R.37E.
R.38E.
R.39E.
R.40E.

APPENDIX B

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U. S. Department of the Interior

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation.

The Department assesses our energy and mineral resources and works to assure that they are managed in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility of the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U. S. administration.

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